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Impact of Area under Cultivation, Water Availability, Credit Disbursement, and Fertilizer Off-take on Wheat Production in Pakistan

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ABSTRACT

This study investigates the impact of area under wheat cultivation, water availability, credit disbursement and fertilizers off- take on wheat production in Pakistan using annual time series data over the period of 1982 to 2011. The present study employed a log-linear Cobb-Douglas production function in order to analyze the data. The empirical results from the model show that area under wheat cultivation, water availability, and credit disbursement has positive impact on wheat production. On the other hand, the empirical results show that fertilizer off-take has a negative and no significant impact on wheat production. The results of regression analysis showed the following: a1 percent increase in area under wheat cultivation increased wheat production by 1.20 percent tones; 1 percent increase in credit disbursement increased wheat production by 0.12 percent tones; 1 percent increase in water availability leads to increase in wheat production by 0.65 percent tones respectively. The study recommends that appropriate doses of fertilizer should be increased. Also, agricultural credit disbursement to wheat growers can further increase its production.

KEYWORDS: Wheat Production, Cultivated Area, Credit Disbursement, Fertilizers Off-take, Cobb-Douglas

1. INTRODUCTION

Wheat (*Triticumaestivum l.*) is the major cereal crop and it is staple food of the world population. In addition, wheat is an important globally-traded commodity[1]. Wheat is the main source of carbohydrates for the human diet. It supplies 68 percent of the calories [2, 3].It is used to make the flour for leavened, steamed breads, pasta, noodles, cookies etc. Pakistan ispart of the top ten wheat producing countries in the world. However, Pakistan's production is lower than China, India, and USA etc. reported by [4].The list of top ten wheat producing countries is shown in(Table 1).The daily diet of the Pakistani population is mostly based on the cereal wheat crop. In terms of production, consumption and cultivated area, main wheat producing provinces are Punjab, Sindh, Balochistan and KPK as showed in Table 2[5].In Pakistan, wheat crop is grown by 80 % of the farmers [6]. According to the economic survey of Pakistan [7], this crop contributes about 2.1 percent to GDP and10 percent value added in agriculture. The total cultivation area of wheat crop decreased to 9180(000, hectares) from the previous year's cultivation area of 9199 (000, hectares), which shows 0.2 percent decrease. Whereas, the estimated total wheat production is 25.478 million tones. This indicates a 1.9 percent decrease from last year's production of 25.979 million tones. The total wheat production was declined due to various natural calamities, such as flood, droughts and repaid population growth.

Table 1: World Top 10 Wheat Producer (in million metric tons)

Rank	Country	2013
---	World	713
1	China	122
2	India	94
3	United states	58
4	Russia	52
5	France	39
6	Canada	38
7	Germany	25
8	Pakistan	24
9	Austraila	23
10	Turkey	22
Source: UN Food & Agriculture Organization		

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There existed ups and downs in estimated total wheat production in million tones, total area under cultivation in thousand hectares, and yield of wheat in Kgs /Hecin Pakistan. Figure 1, 2, 3 and 4 shows the percentage changes in wheat production, total area under wheat cultivation, total credit disbursement, fertilizer off-take on wheat, and water availability in Pakistan over the period 1982 to 2011.

Table 2. Province wise area under cultivation and Wheat Production in Pakistan

Year	Punjab	Sindh	KPK	Balochistan	Pakistan
			(Area '000' hectares)		
2000-01	6255.5	810.7	790.3	324.4	8180.9
2001-02	6101.8	875.2	746.9	333.6	8057.5
2002-03	6097.3	863.7	732.1	340.8	8033.9
2003-04	6255.5	878.2	741.6	340.9	8216.2
2004-05	6378.9	887.4	748.6	343.1	8358
2005-06	6483.4	933.2	721.3	310	8447.9
2006-07	6432.8	982.2	754.3	408.9	8578.2
2007-08	6402	989.9	747.4	410.5	8549.8
2008-09	6836.2	1031.4	769.5	408.9	9046
2009-10	6913.5	1092.3	758.3	367.5	9131.6
2010-11	6691	1144.4	724.5	340.8	8900.7
			(Production '000' tones)		
2000-01	15419	2226.5	764	614.2	19023.7
2001-02	14594.4	2101	890.5	640.6	18226.5
2002-03	15355	2109.2	1064.4	654.7	19183.3
2003-04	15639	2172.2	1025.2	663.4	19499.8
2004-05	17375	2508.6	1091.1	637.6	21612.3
2005-06	16776	2750.3	1100.6	649.9	21276.8
2006-07	17853	3409.2	1160.4	872.1	23294.7
2007-08	15607	3411.4	1071.8	868.6	20958.8
2008-09	18420	3540.2	1204.5	868.2	24032.9
2009-10	17919	3703.1	1152.5	536.2	23310.8
2010-11	19041	4287.9	1155.8	729.1	25213.8
Source: Pakistan Statistical Year Book (2011)					

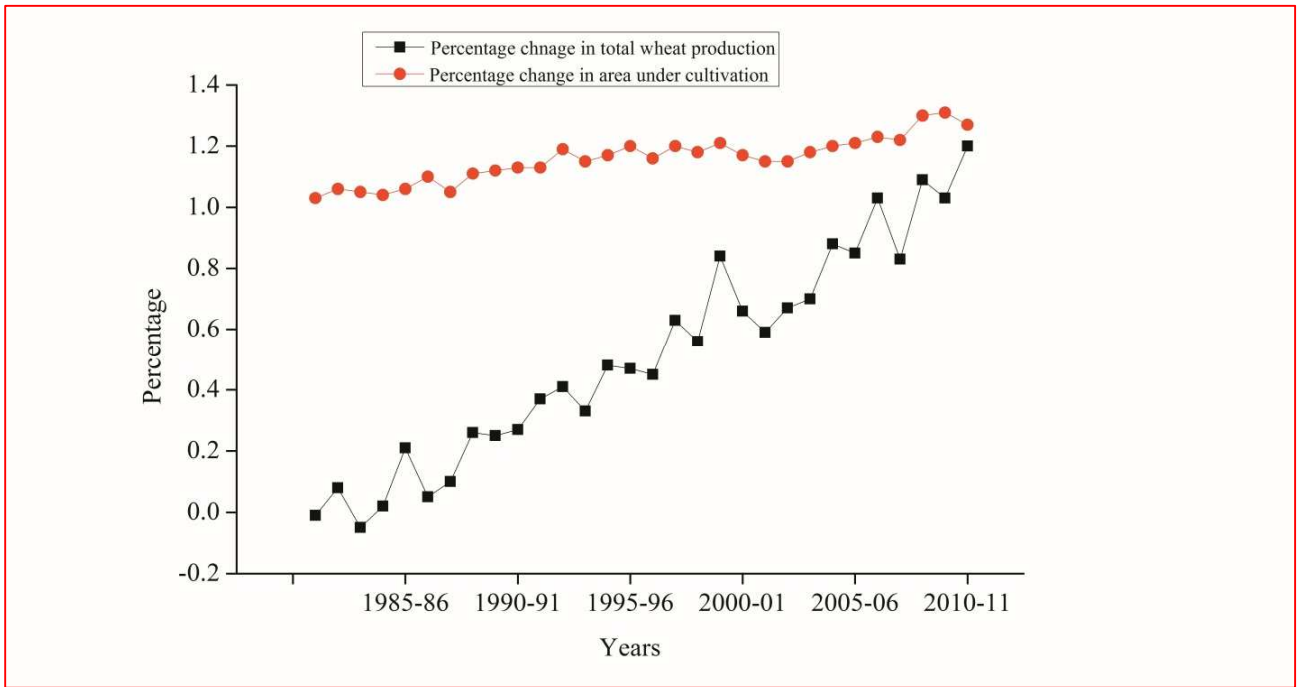

Figure 1: Percentage change in area under wheat cultivation and total wheat production in Pakistan.
Source: Economic Survey of Pakistan (2014-15)

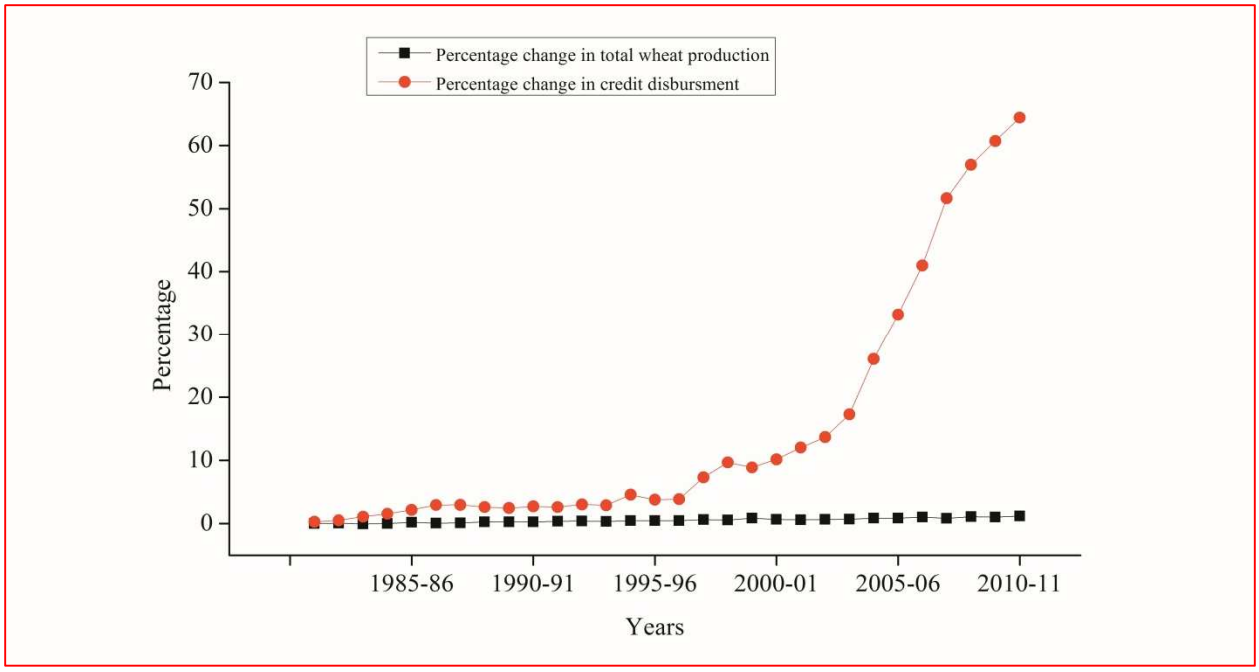

Figure 2: Percentage change in agricultural credit disbursement and total wheat production in Pakistan.
Source: Economic Survey of Pakistan (2014-15)

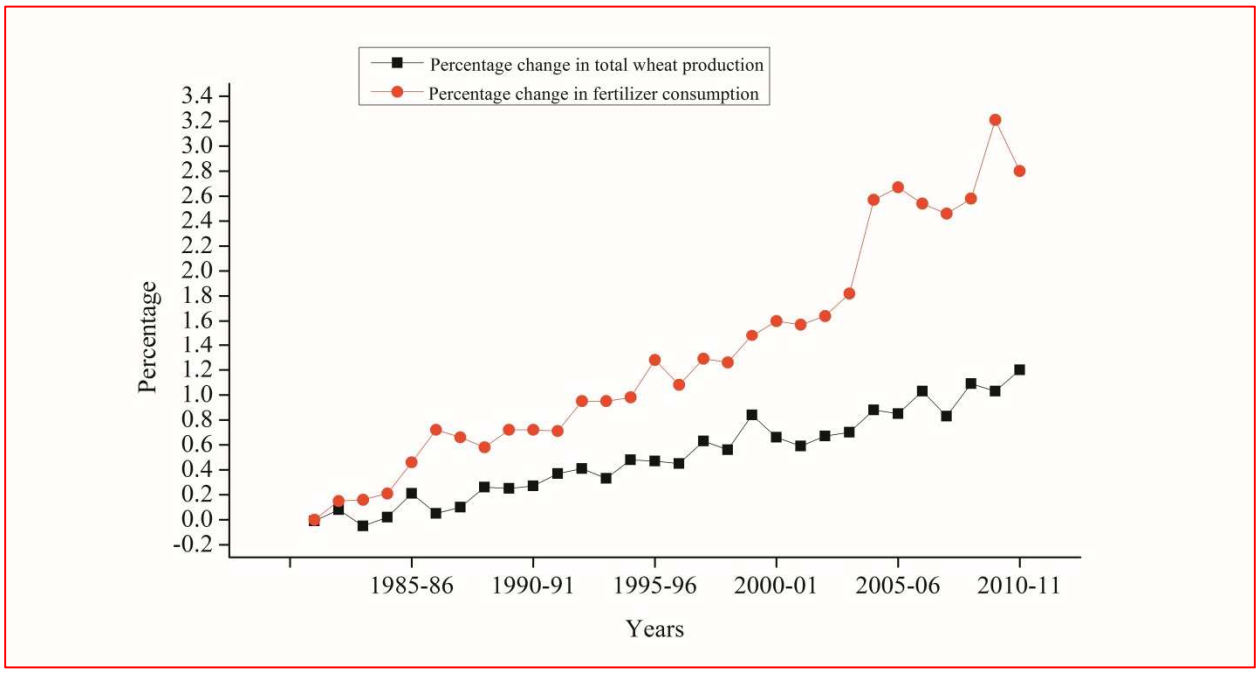

Figure 3: Percentage change in fertilizer Off-take and total wheat production in Pakistan.
Source: Economic Survey of Pakistan (2014-15)

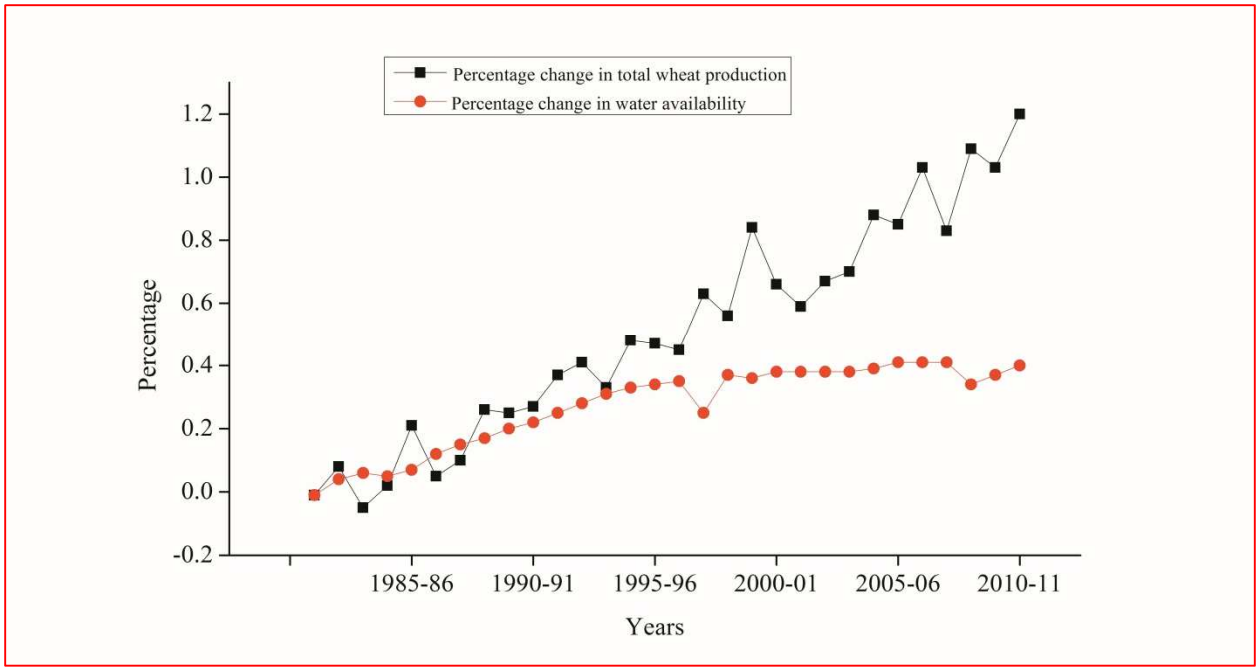

Figure 4: Percentage change in water availability and total wheat production in Pakistan.
Source: Economic Survey of Pakistan (2014-15).

1.1. Objective of the Study

The aim of this research is to examine the impact of area under wheat cultivation, credit disbursement, water availability and fertilizer off-take on wheat production in Pakistan. The scope is limited over the period 1982 to 2011. The choice of this study period is based on the availability of data.

1.2. Significance of the Study

This empirical study will be valuable for the Pakistani Economic Planners and policy makers who are responsible for allocating budgetary for the growth and development of agricultural sector.

1.3. Research Question

What is the effect of major agricultural inputs (area under wheat cultivation, credit disbursement, water availability and fertilizer off-take) on wheat production in Pakistan?

2. LITERATURE REVIEW

Various researchers have studied on several factors affecting on wheat production in different regions. A Study by Carter [8], found out that the credit factor has positive and significant impacts on agricultural production in Pakistan, China and Vietnam. According to [9, 10,11,12,13 and14]they found out positive impact of institutional credit, irrigation, fertilizers and seeds on agricultural production.

Yao [15], investigated the impact of several agricultural inputs on cereal crop production of the peasant farm sector in Ethiopia by using Cobb Douglas Production Function to analyze the data. The researcher used main food crops includes maize, wheat, sorghum, teff, and barley for estimation. The findings of his research showed that 90 percent variations in crop production were described by land and labour. Furthermore, a 1 percent increase in fertilizers leads to a 10 % increase in total production.

Iqbal et al. [16], evaluated the determinants of higher wheat production in irrigated areas of Pakistan by using primary data which was collected from irrigated areas of the country. Cobb Douglas Production Function (CDPF) was applied to analyze the data. The findings of the study included seed rate (Kilograms per acre), total fertilizer nutrients applied rate (Kilograms per acre), number of common cultivations per acre, proportion of wheat acreage affected with lodging, proportion of wheat acreage weeded through chemical control, institutional credit and tenancy.

Javed, et al.[17], assessed the impact of micro-credit of Punjab Rural Support Programme (PRSP) on wheat productivity and sugarcane in Faisalabad. For this study, two field units, Salarwala and Satiana, were selected for

data collection. Findings of this research revealed that micro-credit disbursed by PRSP has a positive impact on wheat and sugarcane productivity. Through this micro-credit scheme the income of the farmers has increased.
Furthermore, Bashir et al. [18], examined the impact of institutional credit on wheat productivity in district Lahore by using Cobb Douglas Production Function (CDPF) and found that agricultural credit has a significant effect on wheat productivity. The results revealed that credit raised the socio-economic conditions of the rural household. It was concluded that productivity of wheat can be increased with the availability of credit to farmers at the time of wheat cultivation by allowing sufficient inputs such as seed, land preparation, modern technologies and fertilizer.
Another study by Hussain[19], examined the impact of major agricultural inputs (area under rice cultivation, credit disbursement, water availability and fertilizer consumption)on rice production in Pakistan by using time series data over the period of 1988-2010.The ADF unit root test, Co-integration test and log-linear CDF method was applied to analyze the data. The findings of his study show that water availability and area under rice cultivation have positive effects on total rice production. On the other hand, credit disbursement and fertilizer consumption have non-significant impact on total rice production in Pakistan. The results of Cobb-Douglas model indicates the following: that 1 percent increase in area under rice cultivation increased total rice production by 1.64 percent tones, and 1 percent increase in water availability increased total rice production by 0.87 percent tones.
In a similar study conducted by Ahmed et al. [20], the authors investigates the effect of agricultural credit on wheat productivity in district Jhang, Pakistan by using field survey of 160 beneficiaries and non-beneficiaries farmers. In order to analyze the data, Cobb Douglas Production Function (CDPF) was applied. The results show that agricultural credit has positive effect on wheat productivity. Another study by Nadia and Chughtai[21], also found out that agricultural credit has positive impact on wheat production.
A study by Chandio et al.[22], have explored the impact of formal credit on agriculture productivity in Pakistan by using secondary data over the period of 1996-2105.An econometric, Ordinary Least Square (OLS) technique was applied to analyze the data. The findings of the study showed that institutional credit has a positive and significant impact on agricultural productivity.
The present study differs from the previous research by looking at the impact of major agricultural inputs such as area under wheat cultivation, agricultural credit disbursement, water availability and fertilizer off-take on wheat production in Pakistan during the period of 1982-2011.

3. MATERIALS AND METHODS

3.1. Data Source

The aim of the article is to analyze the influence of major agricultural inputs on wheat production in Pakistan, annual time series data from 1982-2011 has been used. Recent year data could not be used due to unavailability of Pakistan Statistical year book. Time series data collected from National Fertilizer Development Centre, Economic Survey of Pakistan and Pakistan Statistical Year Book (various issues) [23 and 24].The Five variables are used in this present study such as Total Wheat Production in(000,tones), Area Under Wheat Cultivation in (000,hectares), Water availability in (million acre feet),Agricultural Credit Disbursement in (million rupees) and Fertilizer Off-take in (000, nutrient tones)in Pakistan.

3.2. Specification of Model

The main purpose of this research is to examine the impact of area under wheat cultivation, agricultural credit disbursement, water availability and fertilizer off-take on wheat production in Pakistan the following specified model is estimated:

$$ln\ (TWP) = \beta_0 + \beta_1\, ln\ (AUWC) + \beta_2 ln\ (ACD) + \beta_3\ ln\ (FOW) + \beta_4 ln\ (WA) + \mu \ldots\ (1)$$

Where
Ln (TWP)= Natural logarithm of Total Wheat Production in (000, tones)
Ln (AUWC) = Natural logarithm of Area under Wheat Cultivation in (000, hectares)
Ln (ACD) = Natural logarithm of Agricultural Credit Disbursement in (million rupees)
Ln (FOW) = Natural logarithm of Fertilizers Off take for Wheat in (000, nutrient tones)
Ln (WA) = Natural logarithm of Water Availability in (million acre feet)
μ= Error term
The present study is based on time series data over the period of 1982-2011. An econometric technique, log-linear Cobb-Douglas production function was applied to analyze the data. First to check the stationary of the variables ADF [25, 26],unit root test have been applied. Enders [27] suggests that to check the stationary of the variables should be started from trend and intercept. Based on the estimated results of ADF unit root test, Co-integration technique have been used for estimation [28].

4. RESULTS AND DISCUSSION

4.1. Stationarity Test

Non-stationary of the data produces spurious regression; hence the results of stationary may be misleading. Therefore, it was cognisant to establish the stationary of the data.

The estimated results of ADF unit root test are interpreted in Table 3 shows that Fertilizers Off-take for Wheat (FOW), Water availability (WA) and Agricultural Credit Disbursement (ACD) are non-stationary at their level I(0), while Total Wheat Production (TWP), Area under Wheat Cultivation (AUWC) attained stationary at 1% and 10% of significance at their level forms I(0). However, for same order of integration we again checked TWP, AUWC, FOW, ACD and WA became stationary at their first difference I(1). Therefore, the null hypothesis of non-stationary is rejected at 5% of significance level.

Table: 3 Unit Root Test (ADF)

Variables	At level		First Difference	
	ADF Statistic	Critical values	ADF Statistic	Critical values
LnTWP	-5.574643* (0.0005)	1% -4.309824 5% -3.574244 10% -3.221728	-7.997941 (0.0000)	1% -4.339330 5% -3.587527 10% -3.229230
LnAUWP	-3.308619 (0.0848)***	1% -4.309824 5% -3.574244 10% -3.221728	-8.117582* (0.0000)	-1% 4.323979 5% -3.580623 10% -3.225334
LnACD	-1.282745 (0.8723)	1% -4.309824 5% -3.574244 10%-3.221728	-4.365527* (0.0091)	1% -4.323979 5% -3.580623 10% -3.225334
LnFOW	-2.857733 (0.1898)	1% -4.309824 5% -3.574244 10%-3.221728	-3.667508 (0.0440)**	1% -4.374307 5% -3.603202 10% -3.238054
LnWA	-2.018864 (0.5670)	1% -4.309824 5% -3.574244 10% -3.221728	-7.612910* (0.0000)	1% -4.323979 5% -3.580623 10% -3.225334

Note: *, **, *** indicates 1%, 5%, 10% level of significance respectively.

4.2. The Co-integration Test

We can check long run relationship between the variables by using the Johansen Co-integration technique. The computed results of Co-integration test including intercept without trend and including both intercept and trend is reported in Tables 4 and 5. The values of trace statistic (94.00, 113.70) are greater than critical values (69.81, 88.80), which indicate that long run relationship among the variables. This rejects the null hypothesis of no co-integration. In both cases, the trace test shows 1 co-integrating equation at the 5% significance level.

Table 4. Johansen-Jueslius Co-integration test including (intercept no trend)

Series: ln(TWP) ln(AUWC) ln(ACD) ln(FOW) ln(WA)				
Lags interval:1to1				
Eigenvalue	Trace Statistic	5 Percent Critical Value	Prob**	Hypothesized No.of CE(s)
0.886665	94.00178	69.81889	0.0002	None *
0.514921	33.03434	47.85613	0.5549	At most 1
0.265445	12.77790	29.79707	0.9014	At most 2
0.135344	4.140160	15.49471	0.8919	At most 3
0.002436	0.068293	3.841466	0.7938	At most 4

Trace test shows 1 co-integrating equation at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 5. Johansen-Jueslius Co-integration test including (intercept and trend)

Series: ln(TWP) ln(AUWC) ln(ACD) ln(FOW) ln(WA)				
Lags interval:1to1				
Eigenvalue	Trace Statistic	5 Percent Critical Value	Prob**	Hypothesized No.of CE(s)
0.888207	113.7024	88.80380	0.0003	None *
0.564122	52.35138	63.87610	0.3155	At most 1
0.469019	29.10039	42.91525	0.5559	At most 2
0.232857	11.37560	25.87211	0.8529	At most 3
0.131676	3.953315	12.51798	0.7489	At most 4

Trace test shows 1 co-integrating equation at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

4.3. Regression Analysis

The value of R^2 is 0.94 percent which shows that the overall model fitting is good and 94 percent of variation in wheat production have been explained by four independent variables such as Area Under Wheat Cultivation (AUWC), Fertilizers Off-take for Wheat(FOW), Water availability (WA) and Agricultural Credit Disbursement (ACD). The value of F-statistics (118.7314) is highly significant. Table 6, represents the estimated results of regression analysis regarding the relationship among dependent variable, and four explanatory variables.

Table 6. Regression results including the variables TWP, AUWC, ACD, FOW and WA

Dependent Variable: ln(TWP)				
Method: Least Squares				
Sample: 1982 2011 Included observations: 30				
Explanatory Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.988445	3.535961	-1.410775	0.1706
ln(AUWC)	1.209250	0.458171	2.639300	0.0141
ln(ACD)	0.125275	0.042544	2.944635	0.0069
ln(FOW)	-0.089567	0.165917	-0.539832	0.5941
ln(WA)	0.658932	0.255517	2.578820	0.0162
R-squared0.949993Adjusted R-squared		**0.941991**		
Durbin-Watson stat2.504260				
F-statistic118.7314Prob(F-statistic)0.000000				

The empirical results from the model show that the coefficient of area under wheat cultivation was significant at 0.01% of significance level, which indicated that area under cultivation has strong positive relationship with wheat production in Pakistan. The coefficient of area under wheat cultivation is 1.209250; this means a 1percent increase in area under cultivation increased total wheat production by 1.20percent tones. Furthermore, results indicate that the coefficient of credit disbursement was highly significant, which revealed that credit disbursement has a positive and significant effect on wheat production in Pakistan and hence is an important component for increasing the agricultural production. The coefficient of credit disbursement is 0.125275; this means a 1 percent increase in agricultural credit disbursement increased total wheat production by 0.12 percent tones. Similarly, the coefficient of water availability is 0.658932; which indicates a 1 percent increase in water availability leads to a0.65 percent tones increased in total wheat production. The coefficient of explanatory variables (area under wheat cultivation, water availability, and credit disbursement) has positive signs and these variables are statistically significant at 1% significance level. The results are according to [20, 21 and 30]. They found positive impact of major agricultural inputs on wheat production. However, fertilizer off-take for wheat production has negative sign. The value of Durbin-Watson statistic is (2.5) this indicating no autocorrelation.

5. CONCLUSION AND POLICY IMPLICATIONS

This study empirically investigated the impact of area under wheat cultivation, agricultural credit disbursement, water availability and fertilizer off-take on wheat production in Pakistan from the period of 1983-2011. We found that major agricultural inputs have positive and significant relationship among wheat production in Pakistan. The study found a non-significant relationship between fertilizers off-take and total wheat production. Therefore, fertilizer consumption is an important and major agricultural input for obtaining high yield of wheat. The required doses of fertilizer should be applied at a proper time to enhance the optimum yields. In particular, 1 percent increases in area under wheat cultivation total wheat production increased by1.20 percent tones, a 1 percent increase in credit disbursement brings 0.12 percent tones of total wheat production and a 1 percent increase in water availability total wheat production increased by 0.65 percent tones, respectively. Therefore, our study suggests that the Government of Pakistan should solve the identified problem of wheat growers to enhance wheat productions. This will lead to a high yield by decreasing cost of wheat inputs.

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