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Economic Outlook of Rice Crops in Pakistan: A Time Series Analysis (1990–2021)

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Abstract

This study's main objective is to examine the connections between Pakistan's agricultural GDP and rice production, credit disbursement, water availability, and frtilizer. Data were acquired from a number of sources, including the National Food Security and Research, Economic Survey of Pakistan, FAO, and Pakistan Bureau of Statistics, for the annual time series from 1990 to 2021. Data on the rice crop were evaluated using the augmented Dickey-Fuller test and the ordinary least squares method. Our study found a long-standing relationship between Pakistan's agricultural GDP and rice output, credit disbursement, fertilizer, and water availability. The regression analysis shows that rice production, and credit disbursement all have a significant and positive relationship with agricultural GDP, however fertilizer positive relationship but insignificance and water accessibility has a negative relationship. The study recommends that Pakistan's government implement fresh regulations and finance new initiatives for the improvement of its water resources.

Keywords

GDP, Credit Disbursement, Water Availability, Fertilizer, Yield, OLS Method

Introduction

Rice is Pakistan's second-largest cash crop, and it has a competitive advantage in the production of aromatic basmati rice. As a result, it is a key export for Pakistan, and the government has

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put in place a number of schemes to stimulate enough production. Punjab and Sindh are the two provinces that produce the most rice, with 56% and 39% of the total production, respectively (GOP, 2013).

As wheat yields are lower in Pakistan than in countries like China, France, and the United States, rice is also the country's most important food crop, even more so than wheat (Ozpinar et al., 2006; Rehman et al., 2016a, 2016b, 2016c, 2016d). Tillage and weed infestation are the main causes of low yield, which diminish wheat yields by 50–80%. Tillage is still the primary method for controlling weeds and preparing seedbeds in most parts of the world. To manage weeds, tillage techniques alone are insufficient (Mohanty et al., 2006).

Recently, a variety of rice growing techniques have been created, including direct planting, alternate soaking and drying, a robotic rice amplification system, and an aerobic rice system. In partnership with national and international research organizations, the Pakistan Research Council (PARC) has scaled up and evaluated these systems in the provinces of Punjab and Sindh (IRRI, 2010; Sharif, 2011). For discussions of these systems and technologies, see Rehman et al. (2016a, 2016b, 2016c, 2016d) and Bouman et al. (2007).

We evaluated the efficacy of an aerobic rice system (ARS), which replaces direct seeding with seedling trans-planting. The fact that this method minimizes the cost per unit area makes it the best choice for regions with a labor shortage, claim Pandey and Velasco (2005). The availability of a variety of weedicides further reduces the amount of labor necessary for weeding in this system (Farooq et al., 2011). The system also includes plans for providing irrigation when groundwater levels drop below a critical threshold.

As production systems, aerobic and direct seeded rice are possibly more economical and environmentally sustainable due to their overall performance. As a result, in environments where water is scarce, the aerobic rice system may be a desirable alternative technological improvement (Bouman et al., 2007).

Literature Review

Rice is a key crop for many countries. Southeast Australia, northeastern China, and the wet tropics are among the regions where it is cultivated. It also varies from sea level to an elevation of about 2500 meters in the more temperate parts of Nepal and Bhutan. While Asia is where most rice is farmed, there are some suitable areas in Oceania and Europe as well. Rice is produced in a range of temperatures and on a variety of soils with radically different soil characteristics because of its enormous global distribution. Due to these typical rice soils, early studies concentrated on flooded rice cultivation in Asia (IRRI, 1978; IRRI, 1985; Kawaguchi and Kyuma, 1977; Moormann and Breemen, 1978; 2000). However, most studies have focused on the specifics of waterlogged soil treatments (Banta and Mandoza, 1984; Kirk, 2004; Kögel-Knabner et al., 2010; Ladha et al., 1992; Ponnam- peruma, 1972; Wassmann et al., 2000).

As a result, there has been little recent research on spatial representation and rice soil dispersion. As a result, there is a lack of comparative quantitative data on paddy soil quality and rice production systems. In this situation, local experts can frequently offer solutions to important concerns like soil quality that necessitate qualitative research. A greater understanding of the spatial representation of soil quality and restrictions on rice production could have a variety of applications. The purpose and focus of agricultural research can be assessed using spatial data on environmental constraints on crop production (Hijmans et al., 2003); communication technologies can also be useful (Singh and Singh, 2010). Understanding the spatial distribution and characteristics of soil, climate, hydrology, and abiotic traits can help with specific challenges in rice production, such as finding more tolerant varieties of rice and dealing with submergence tolerance (Xu et al., 2006), phosphorus deficiency tolerance (Gamuyao et al., 2012), phosphorus deficiency tolerance, and water stress tolerance (Huang et al., 2010).

Similar to that, this kind of information can be used to enhance the research and communication of management options and difficulties related to a particular soil. The traditional ways of growing rice are susceptible to issues with the water supply and diminishing energy sources. This can be accomplished using resource conservation technology.With the aid of this kind of information, the analysis and communication of management decisions and issues relevant to a specific soil can also be improved (CGIAR, 2010).

Rice production technique has shown tremendous potential to enhance resource usage by producing rice similarly to other crops, i.e., in non-banked and non-flooded places, like unsaturated soils under wheat and maize, or by drought-sowing highland rice. Traditional lowland and upland rice varieties are also crossed to produce aerobic rice varieties, which combine the production potential of lowland kinds with the tolerance for aerobic soils of highland varieties (Atlin et al., 2006). ARS have been developed in temperate regions and are currently being evaluated in tropical and subtropical nations in order to increase local farmer incomes and regional and national food security (Maclean et al., 2002; Prasad and Donald, 2011).

When growing paddy rice, a different variety of rice cultivation, seedlings that are 25 to 35 days old are often transplanted onto appropriately prepared puddled soils. This controls the growth and infestation of weeds as well as water purification, however for healthy growth, it requires a lot of fresh water. increasing paddy rice poses a serious danger to Pakistan's food security because to a lack of water reservoirs and an increasing population (Briscoe and Qamar, 2009).

According to one estimate (GOP, 2012), the amount of water available for canal irrigation was 10% less than the long-term average water use of 128 billion m3 during the fiscal year 2011-2012 (July 1-June 30). The groundwater table is declining at a rate of about 0.3 m per year due to increased groundwater exploitation and consumption of over 7 m (Kahlown et al., 2007; Rehman et al., 2016a, 2016b, 2016c, 2016d). Due to greater groundwater pumping expenses spurred on by rising fuel prices, there has been a decline in net economic earnings. Lack of labor is another issue that affects rice farming, slowing down output and delaying the transplanting of seedlings when manual evacuation and transplantation are required. According to several studies (Baloch et al., 2005; Chaudhary et al., 2001; Farooq et al., 2011), the existing labor force is primarily made up of teenage girls and unskilled contract workers, which leads to uneven plantations and economic densities that are below the agronomically ideal ones as well as a lack of quality assurance.

According to an FAO assessment from 2000, irrigated agriculture uses 69% of all freshwater resources and generates around 40% of the world's food. In addition, it is predicted that between 2000 and 2025, the demand for cereals like rice and wheat will increase by 1.27% annually due to the expanding world population (Rosegrant and Cai, 2000). In order to meet the anticipated food demand, irrigated agriculture will need a 17% increase in freshwater resources, according to Seregeldin (1999). Where population growth is strong and freshwater resources are limited, pressure has been placed on the agriculture sector in both agricultural and semi-agricultural nations to produce higher yields, thus intensifying water consumption to provide more for a growing population. This trend drives the bulk production of cereals, especially rice and wheat, to use inadequate amounts of irrigation.

It is projected that Pakistan may soon have a water deficit for irrigation. According to Kahlown and Kemper (2004) and Rehman et al. (2016), 2016a, 2016b, 2016c, 2016d, farmers in this region often irrigate fields in bundled units using an open flooded system, which results in poor water homogeneity, prolonged irrigation events, and over-irrigation. The tendency to rely on standing water during the growing season in order to enhance rice harvests has led to poor water use efficiency. According to numerous studies conducted in Pakistan, each irrigation uses between 13 and 18 cm of water, which is much more than the 8 cm that is normally used in between irrigation events (Kahlown et al., 2001). Furthermore, the use of pressurized irrigation has enabled the growing of wheat and rice in a number of countries. Water depth can be increased by sprinkler irrigation, including portable rain guns, and in the Indian subcontinent's current climate, sprinklers have been used to raise farm irrigation effectiveness by up to 80%.

Data and Methodology

This analysis is based on time series data. From 1990 to 2021, annual time series data on the agricultural GDP, rice crop output, and water availability have been collected from the National Food Security and Research, Economic Survey of Pakistan, and Pakistan Bureau of Statistics (a number of publications).

(a)Model Specification

To examine the relationship between the agricultural GDP and rice crop output, credit disbursement, fertilizer and water availability, the following model was used:

$$Y = AX_1^{\beta_1} + AX_2^{\beta_2} + AX_3^{\beta_3} + AX_4^{4}$$

Taking the natural logarithm of eq. (1) and considering three explanatory variables, eq. (4) was converted to:

$$LnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \mu_t$$

LnY= Natural Logarithm of Agriculture GDP (in million PKR)

β_0 = Natural Logarithm of A(Intercept)

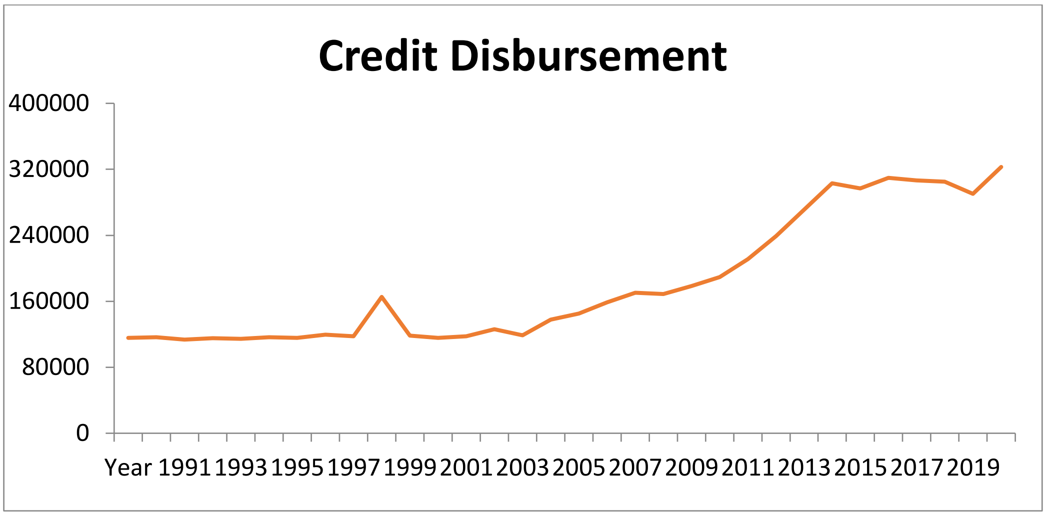
lnX_1 = Natural Logarithm of yield of rice (in thousand tons)

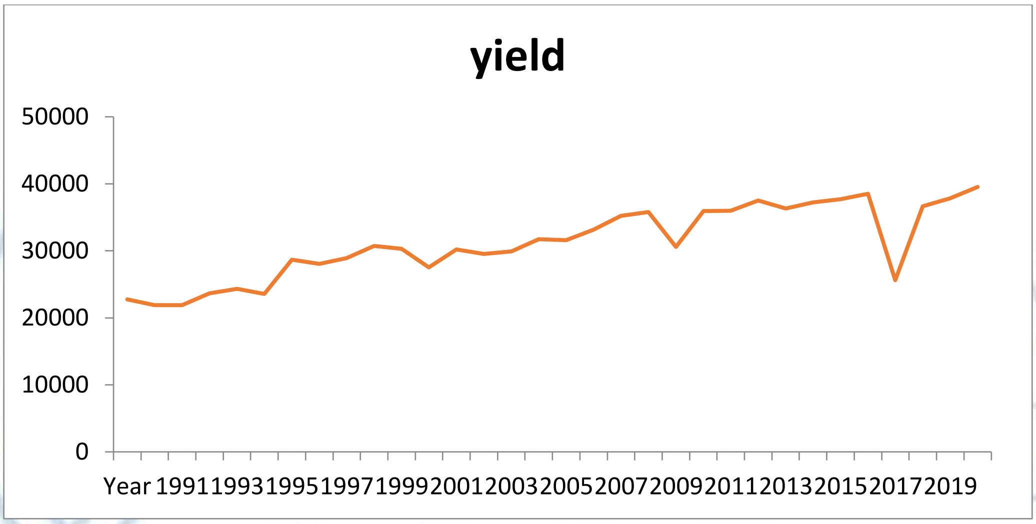
lnX_2 = Natural Logarithm of credit disbursement.

lnX_3 = Natural Logarithm of water availability (in million acre-feet)

lnX_4 = Natural Logarithm of fertilizer (in tons)

To determine the stationarity of study variables, we first checked for unit root using the modified Dickey and Fuller (1981) unit root test. The effect of rice output, credit disbursement, fertilizer, and water availability on the agricultural GDP of Pakistan for 1990–2021 was finally examined using ordinary least square (OLS).





Results and discussion

a. Unit Root Test

Variable	At Level		First Level	
	t-statistics	cretical value	t-statistics	cretical value
Ln(Yield)	(-3.999) 0.0017	1% -4.175640 5% -3.513075 10% -3.186854	(-4.876) (0.000)	1% -4.175640 5% -3.513075 10% -3.186854
Ln(Fertilizer)	(-3.7361) (0.0386)	1% -4.175640 5% -3.513075 10% -3.186854	(-5.3282) (0.0009)	1% -4.175640 5% -3.513075 10% -3.186854

Ln (WA)	(-5.4050) 0.0006	1% -4.175640 5% -3.513075 10% -3.186854	(8.5325) (0.0000)	1% -4.175640 5% -3.513075 10% -3.186854
Ln(CD)	(-5.9432) (0.0000)	1% -4.175640 5% -3.513075 10% -3.186854	(-6.1912) (0.0001)	1% -4.175640 5% -3.513075 10% -3.186854
Ln(GDP)	(-3.5469) (0.0598)	1% -4.175640 5% -3.513075 10% -3.186854	(-4.6789) (0.0040)	1% -4.175640 5% -3.513075 10% -3.186854

The stationarity of each variable was examined using the ADF unit root test, which also considered trend and intercept. According to the estimated ADF test results presented in Table 1, the level forms of (AGRGDP), (Fertilizer), (Area), (credit disbursement), and (WA) are stationary.

Regression Analysis

To investigate the relationship between the variables rice crop output of rice crop, credit disbursement, and water availability with the agricultural GDP of Pakistan, OLS was applied. The results of the regression analysis are presented in Table 4, showing a high value of R2 of 0.765 or 76.5%. This implies that around 765% of the total variation in agricultural GDP can be explained by the four independent variables. The computed value of the F-statistic is 22.22, with a probability value of 0.000000, which indicates the fitness of the overall model.

Dependent Variable: Agri GDP
Method: Least Squares
Date: 5/09/23 Time: 23:23
Sample: 1990 2021
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_YIELD_	37.95077	6.408418	5.922018	0.0000
LN_WA	-3.007628	14.70645	-0.204511	0.8395

LN_FERTILIZER	22.43438	25.51596	0.879230	0.3870
LN_CRE	4.342726	1.848742	2.349016	0.0264
C	-529.2966	136.3577	-3.881678	0.0006

R-squared	0.767047	Mean dependent var	12.07724
Adjusted R-squared	0.732536	S.D. dependent var	8.723004
S.E. of regression	4.511272	Akaike info criterion	5.993637
Sum squared resid	549.4926	Schwarz criterion	6.222658
Log likelihood	-90.89818	Hannan-Quinn criter.	6.069551
F-statistic	22.22582	Durbin-Watson stat	1.218632
Prob(F-statistic)	0.000000		

Result Discussion

The results of the regression analysis show the coefficient of output of rice is highly significant at both the 1% and 5% of significance levels, indicating a strong and positive relationship between agricultural GDP and rice output. This means that every 1% increase in rice yieeld increased agricultural GDP by 37.95%. Our results, according to Anyanwu (2010), show a posi- tive relationship between rice crop output and agricultural GDP. Further, the coefficient of the area under rice crop production is also highly significant at both the 1% and 5% of significance levels, indicating a significant and positive relationship between the credit disbursement and agricultural GDP. This implies that every 1% increase in credit disbursement leads to a 4.34% increase in agricultural GDP and Fertilizer positive relation but insignificance and water availability are insignificance and negative relationship with agricultural GDP. In Pakistan, agricultural productivity is much lower compared to developed countries due to low water availability.

Conclusion and Recommendations

This study examined the relationship between the agricultural GDP of Pakistan and the rice crop output area under rice crop production, and water availability during 1970–2015. Time series data were collected from the National Food Security and Research, various issues of the Economic Survey of Pakistan, and the Pakistan Statistical Year Book. For analysis the ADF unit root test, and OLS were used. The results of regression analysis showed that rice output, credit disbursement have a positive and significant relationship with the agricultural GDP, while water availably and fertilizer has a insignificance and negative relationship.

Therefore, this study suggests and recommends that the government of Pakistan seeks out new policies and funding schemes for the development and improvement of water availability such as drip irrigation system, rainwater harvesting, new technologies such as bed system by which production will be increased and also water should be saved and give to the subsidies on fertilizer.

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