

Impact of Agricultural Loan Disbursement and Chemical Fertilizer Use on the Rice Production in Bangladesh

Mala Rani Das¹ and Mohammad Amzad Hossain²

ABSTRACT

Agriculture is one of the important issues of Bangladesh, where a larger share is related to it for livelihood, food, and socio-economic activities. Agriculture draws considerable attention and is the backbone of the Bangladesh economy. Besides enhancing food and raw materials, agriculture also enhances employment opportunities to a vast number of the population. Agriculture is affected by many factors; among those two crucial factors are agricultural credit and chemical fertilizer. This paper examined the effect of agricultural loan & chemical fertilizer on the total rice production in Bangladesh during the time 1995 to 2016. The study has used data from the economic review 2017. Data are found stationary at the difference at 1% and 5% level of significance using Augment Dicky Fuller (ADF) test. Then the study adopted multiple regressions to see the influence on agricultural loan and chemical fertilizer on total rice production. The result showed that agricultural credit has a positive & statistically significant effect on total rice production, and chemical fertilizer has a positive effect on the total rice production of Bangladesh but not statistically significant.

Keyword(s): Total rice production, agricultural loan, chemical fertilizer, multiple regression.
J.E.L. Classification: Q10, Q14, O13, C19.

INTRODUCTION

Agriculture can be viewed as the 'golden chapter' for the economic development of Bangladesh. The consistent hard work of around 1.5 crore farmers along with their family from dawn to dusk is related to this agriculture, and continuously, they are enriching our food stock by producing agricultural products. So to retain the flow of social development, economic growth, as well as economic development, proper incentive, in the form of agricultural credit, knows no bound. The contribution of agriculture is about 15% of GDP. Around 43% of people are directly engaged in agriculture, and around 85% of people are directly and indirectly dependent on agriculture for livings and employment (Krishi Bank Agri Policy, 2017). The agriculture sector has its significance not only for providing people with food, nutrition, but also for increasing

¹ Department of Economics, Jahangirnagar University, Savar, Dhaka. Email: mrdas@juniv.edu

² Department of Economics, Jahangirnagar University, Savar, Dhaka

employment opportunities, reducing poverty, and improving the standard of livings. As a result, the agriculture sector has become a different sector for social activities. Without sustained growth in agriculture, it will be impossible for Bangladesh to become a middle-income country within 2021. Bangladesh is an agri-based country. The agriculture sector in Bangladesh is the main driving force of the economy, ensuring food security and accelerated economic growth of the economy. Agricultural land day by day is dangerously decreasing because of the increasing population. It is necessary to utilize our limited land in a better way to ensure higher production for feeding the growing population of the country. In this regard, new technology, machinery, quality seeds, irrigation facilities, fertilizer, etc. are very important. The present study aims to explore the impact of the agricultural loan disbursement and the use of chemical fertilizer on total rice production (Aus, Aman & Boro) in Bangladesh. For ensuring long-term food security, i.e., to make Bangladesh self-sufficient in the agricultural food sector, the agriculture sector enjoys special priority in the economy. Over the last few years, there has been an increasing trend in food production (Table-1).

Table 1: Food Grains Production (In lakh MT)

Food Grains	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Aus	21.00	22.18	21.33	23.33	21.58	23.26	23.28	22.89	21.33	27.09	27.02
Aman	122.25	126.60	127.91	127.98	128.97	130.23	131.90	134.83	136.56	139.94	141.34
Boro	182.87	185.25	186.17	187.59	187.78	190.07	191.92	189.38	180.24***	195.76	196.23
Total	326.12	334.03	335.41	338.90	338.33	343.56	347.10	347.10	338.14	362.79	364.59

Source: Bangladesh Bureau of Statistics (BBS), Ministry of Agriculture.* provisional figure. BER, 2017 & BER, 2019

According to the estimates of BBS, food grains production was 388.14 lakh metric tons in FY2016-17, and total internal procurement of food grains was 13.83 lakh MT, and total import of food grains through public and private sectors was 58.23 lakh MT (rice 1.33 lakh MT and wheat 56.90 lakh MT). TK 17,550 crore was approximately targeted to be allotted as agricultural credit, while TK 20,998 crore was disbursed until June 2017, which was 120 % of the target (BER, 2017). According to the Quarterly Labor Force Survey 2015-16, the agriculture sector (crops, animal farming, forest, and fishing) contributed 14.74 percent to the economy's GDP. It provided employment about 41 percent of the Labor Force. Modern agricultural practices such as the use of High Yielding Variety (HYV) are needed to achieve increased food demand, which led to increasing demand for both organic and chemical fertilizers. In FY2016-17, the total quantity of chemical fertilizer used was 49.06 lakh MT. The use of urea was the highest. For ensuring food security, agricultural credit also plays a vital role. The farm loan is necessary to have other inputs used in agriculture. In FY2016-17, TK 20,998.70 crore (119.65 percent of target) has been disbursed as agriculture and rural credit against the target of TK 17,550 crore through schedule banks (BER, 2017). Agricultural productivity is dependent on adequate transport facilities, irrigation, institutional credit, proper marketing facilities, supplying quality inputs, enhancing agricultural knowledge, reducing the pressure of population on land, providing better manure seeds, land reforms, co-operating farming, developing cottage and small scale industries (www.economicdiscussion.net). Agriculture productivity is affected by many things;

however, the study examines the impact of agricultural loan and chemical fertilizer on the total rice production of Bangladesh. Credit is badly needed for any kind of business environment, and the agricultural sector is no exception, as it helps transform the agricultural sector into a modern sector. On the other hand, fertilizer adds nutrients to the soil to promote soil fertility and increase plant growth.

LITERATURE REVIEW

Studying the maize cultivation, Akter et al. (2020) identified that credit had a positive effect on fertilizer demand as well as on irrigation demand and, ultimately, a positive impact on maize production. The study used multiple regression analyses to analyze the effect of credit on maize production; it also used the "Modified" OECD scale to measure calorie intake level. The study revealed that 6.67% of the respondents were ultra-poor, about 20% were hardcore poor, approximately 21.67% were absolute poor as the calorie intake per day was 1481.991 k.cal, 1722.133 k.cal, and 1934.605 k.cal respectively. And the rest 51.67% were in the non-poor group. By using cointegration and causality analysis between agricultural credit and total rice production in Bangladesh from the time 1981 to 2015 (Islam, 2016) indicated that there was a stable long-run relationship between these two variables and a bi-directional causality between the two variables. (Bidisha, 2015) conducted a study based on data of Household Income and Expenditure Survey 2010 & using least squares (2SLS) approach, the study found that credit had a significant role in agricultural production. Chakrabarty et al. (2014) used both primary and secondary data to examine the use of fertilizer and pesticide for crop production in the Tangail district of Bangladesh. Urea among all the fertilizers (Urea, MP, DAP/TSP) was mostly used fertilizer and also organic fertilizer (although in less amount). The study concluded that fertilizers and pesticides were excessively used for accelerating the production of crops, especially paddy. (Islam et al., 2014) wanted to find out whether small-scale agricultural credit of Grameen Bank and Bangladesh Krishi Bank raise the economic standard of rural people or not and concluded that institutional credit accelerates the economic development of Bangladesh. According to (Alauddin & Biswas, 2014), formal sector credit has increased, but the informal sector of agricultural credit is still substantial. Rahman (2011) is concerned with private commercial banks and foreign commercial banks' agricultural credit's impact on farm production and found a strong positive correlation between them.

Patra et al. (2016) discussed the change in farming practice. They opined that chemical fertilizer had no strong correlation with agricultural production and also expressed concern over the improper usage of N-P-K composition. Das et al., (2009), selecting four states that belonged to India and using Dynamic Panel Data Analysis with Instrumental Variables as well as adopting Arellano-Bond Regression, disclosed that agricultural credit had a supportive impact on agriculture output. Chaturvedi (2005) performed a field experiment during the time 2002 & 2003 at Bilaspur Chhattisgarh, India, and found that fertilizer like nitrogen fertilizers, SuperNet, and ammonium sulfate nitrate, but urea, had a significant influence on the production of hybrid rice ('Proagro 6207').

Based on cross-sectional data collected from 18 villages located in three districts of Pakistan, Chandio et al. (2018) wanted to investigate the effect of short-term loans and long-term loans on wheat productivity of small farms in Sindh, which is a district of Pakistan. Researchers

reassured that agricultural credit had a significant positive effect on wheat productivity, where the short-term loan had a stronger effect on the long-term loan. They also explored the connection between fertilizer consumption and rice production in Pakistan from 1984 to 2014. Applying ARDL model, they expressed that area, as well as fertilizer consumption for rice, had a significant impact on rice production in both the short-run and long-run. Water availability, however, had a statistically significant impact on rice production in the long-run, but in the short-run, it had a statistically insignificant effect.

Using the Johansen Co-integration test and utilizing data from 1996 to 2015, Chandio et al., (2016) showed that a 1% increase in credit would increase the agricultural output by 0.86%. Other studies, such as Hussain et al., (2015) analyzed data from 1973 to 2009 & treated agriculture gross domestic product as the dependent variable and total labor force, agriculture credit, number of tractors and total cultivated land as independent variables and green revolution used as a dummy variable. Applying the ECM and Johansen cointegration approach, the study identified that institutional credit had a significant impact on the agricultural productivity of Pakistan. In contrast, cultivated land and labor force had no significant impact on agricultural production. Hussain (2012), utilizing a log-linear Cobb-Douglas production function, mentioned that an area under cultivation with water availability had a positive and statistically significant impact, while credit disbursement & fertilizer consumption had a positive but statistically insignificant impact on total rice production. Ayaz & Hussain (2011) related cross-sectional survey data of 300 farming households from the Faisalabad district of Punjab for the 2008-2009 period to estimate the farming sector efficiency using Stochastic Frontier Analysis (SFA) approach. They noted that there was 16 percent inefficiency in the observed farms and also indicated that credit was the most influencing factor for farming efficiency.

Sekumade (2017) wanted to examine the economic effect of organic and inorganic fertilizers on the yield of maize in Oyo State, Nigeria. With purposive sampling as well as with well-structured questionnaire, data were collected from 120 maize farmers. There were various determinants of using organic and inorganic fertilizers. However, from costs and returns analysis, it was found that an inorganic farmer user who invested ₦1 felt ₦1.59 as revenue hence obtained ₦0.59k on each Naira expended, where an organic farmer user who invested ₦1 felt ₦1.67 as revenue thereby obtained ₦0.67k on each Naira spent. Ngozi (2015) examined the impact of agricultural loans on food production, problems, and prospects. Secondary data covering the period 1992-2012 were analyzed with the aid of multiple regression through the use of SPSS with F-test and student t-test. The study concluded that agricultural loans had a significant and positive effect on food production.

Using SPSS (Ibe, 2014) wanted to explore the impact of banks and the public sector's financing activities on agricultural output in Nigeria during the period from 1990 to 2007. The study revealed that Commercial banks' credit and Prices of farm products had a significant positive impact on agricultural productivity. In contrast, government financial allocation to the agricultural sector had not such significant positive effects.

Obilor (2013) expressed a surprising result that commercial banks' credit to the agricultural sector and prices of farm products for the period 1984 to 2007 had no significant positive impact on agricultural productivity in Nigeria; however, agrarian scheme loan by purpose and government fund allocation to the farm sector had led to significant positive growth in agricultural productivity in Nigeria.

Sulemana & Adjei (2015), employing a case study and quasi-experimental (control-group) techniques, confirmed a significant positive impact of microfinance on agricultural production. Nuhu et al. (2014) used purposive sampling of hundred (100) farmers who had accessed microfinance in East Mamprusi district of Ghana and traced that a GH ₵1 increase in microcredit to the farmers would increase crop production by more than one-third (0.314) of a bag. Tayoh et al. (2016) collected necessary data from local farmers on chemical fertilizer's application and its impact on food safety and expressed that 78% of farmers were conscious about the improper use of chemical fertilizers on food crops could create severe problems to human health when consumed & also explored that 85% had no formal training on the use of chemical fertilizers. Savci (2012) illustrated that a worldwide increase in chemical fertilizer consumption creates environmental problems. Intensive use of fertilizer causes water eutrophication, soil, and air pollution.

Matsumoto & Yamano (2010) emphasized fertilizer credit increases input application for crop production. Using two-year panel data of 420 households in rural Ethiopia credit facility increased inorganic fertilizer use by 35 kilograms per household as well as increased the yield of teff by 37 percent. But the credit program had no significant influence on net crop income per cultivated area and the per capita income. Reviewing the literature, we find the research gap in conducting this study, as very few studies have been conducted adopting the OLS method to see the impact of the agricultural loan disbursement and chemical fertilizer together on the total rice production of Bangladesh.

DATA AND METHODOLOGY

Variables of this study are the agriculture loan disbursement (Loan in crore taka), chemical fertilizer (urea, TSP, DAP, MOP, SSP, NPKS, ASP, Zinc, Gypsum and others in thousand metric tons) and total rice production (aus, aman & boro) in thousand metric tons. Data used in this study are secondary data, which is taken from Bangladesh's economic review from 1995 to 2017. Data have been converted to logarithmic forms of the variables to maintain statistical simplicity and to obtain desirable properties for the estimates. The study uses the method of multiple regression followed by some tests such as Breusch-Pagan test, Breusch-Godfrey test, Jarque-Bera test, VIF for Multicollinearity test, and stability test for the dependent variable. The results of the study have been analyzed by using MS Excel, Stata 12, and Eviews 9.5.

The multi-linear regression model can be written as-

$$Y_t = \beta_1 + \beta_2 X_{1t} + \beta_3 X_{2t} + \dots + \beta_k X_{kt} + u_t \dots \dots \dots (1)$$

The model here for this analysis includes a number variable:

$$\text{Lntrp} = \beta_0 + \beta_1 \text{Lnloan} + \beta_2 \text{Lnfertilizer} + u_i$$

Where Lntrp is total rice production, Lnloan is loan disbursement, Ln fertilizer is chemical fertilizer, β_0 is the intercept term, β_1 and β_2 are the slope coefficient. β_1 shows how much of the value of Lntrp changes as a result of 1% change in the value of Lnloan keeping other explanatory variables constant, and β_2 shows how much of the value of Lntrp changes as a result of 1% change in the value of Ln fertilizer keeping other explanatory variables constant and u_i is the

disturbance term that includes all the variables other than loan and chemical fertilizer that affect the total rice production.

Breusch-Pagan Test

On the basis of OLS model in (1) - homoskedasticity assumption implies $\text{Var}(u_i|X_i) = \sigma^2 \forall i \in 1, 2, \dots, n$. If this is violated then we have: $\text{Var}(u_i|X_i) = \sigma_i^2 \forall i \in 1, 2, \dots, n$.

The residual followed by the regression model (in 1) can be written as:

$$\hat{u}_i^2 = \delta_1 + \delta_2 X_{i1} + \delta_3 X_{i2} + \dots + \delta_k X_{ik} + v \dots \dots \dots (2)$$

Followed by Chi-Square distribution with k degrees of freedom, the set of hypotheses (from 2) are constructed: $H_0 : \delta_i = 0$ and $H_1 : \delta_i \neq 0$. If the null hypothesis is not rejected, then δ is homoscedastic or, in other words, u (in 1) is homoscedastic. If the null hypothesis is rejected, then u (in 1) is heteroscedastic.

Breusch-Godfrey Test

The autoregressive scheme AR (ρ) based on u (in 1) is:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \dots + \rho_k u_{t-k} + v_t \dots \dots \dots (3)$$

According to Breusch and Godfrey, the following auxiliary regression model is constructed:

$$\hat{u}_t = \lambda_0 + \gamma_1 X_{1t} + \gamma_2 X_{2t} + \rho_1 \hat{u}_{t-1} + \rho_2 \hat{u}_{t-2} + \dots + \rho_k \hat{u}_{t-k} + \varepsilon_t \dots \dots \dots (4)$$

Followed by Chi-Square distribution with k degrees of freedom, the set of hypotheses (from 3 followed by 4) are constructed: $H_0 : \rho_i = 0$ and $H_1 : \rho_i \neq 0$. If the null hypothesis is not rejected, then there is no serial correlation between u_t and u_{t-1} or, in other words, u s (in 1) do not show any serial correlation. If the null hypothesis is rejected, then there exists a serial correlation among u s (in 1).

Jarque-Bera Test

The Jarque-Bera test statistic for residual followed by the regression model (in 1) is:

$$JB(\hat{u}_t) = \frac{n-k}{6} [S^2 + \frac{1}{4}(C-3)^2] \dots \dots \dots (5)$$

Where n is the sample size, s is the skewness, C is kurtosis, and k is the number of regressors. In this case, Chi-Square distribution is followed with degrees of freedom of 2 and thus a set of null hypotheses (on the basis of 5): $H_0 : s = 0, c = 3$ and $H_1 : s \neq 0, c \neq 3$. If the null hypothesis is not rejected, then the residual follow the normal distribution or, in other words, u (in 1) follows the normal distribution. If the null hypothesis is rejected, u (in 1) do not show normal distribution.

RESULT DISCUSSION

Descriptive statistics of the variables

Table 2: Descriptive Statistics of the Variables

Variable	Obs	Mean	Std.Dev.	Min	Max
Lntrp	22	10.17535	.2369206	9.731096	10.45478
Lnloan	22	8.569715	.8558082	7.300898	9.778287
Lnfertilizer	22	8.15516	.176033	7.878761	8.479491

Table 2 shows the summary statistics of the variables chosen over the time period. From the table we see that the mean of Lntrp, Lnloan and Lnfertilizer are 10.17355, 8.569715 and 8.15516, respectively.

Result of Augmented-Dickey-Fuller (ADF) test

Table 3: Result of Augmented-Dickey-Fuller (ADF) test

variables	ADF (with trend)		ADF (without trend)	
	Level	First difference	Level	First difference
Lntrp	-3.010900	-3.976276**	-1.950698	-3.632224**
Lnloan	-3.157612	-5.433514*	-0.538347	-5.545710*
Lnfertilizer	-3.381329***	-5.524295*	-1.405898	-5.442764*

(Note: *is 1% level of significance, ** is 5% level of significance, and *** is 10% level of significance.)

Table 3 shows that Lntrp is stationary at 5% level of significance and Lnloan & Lnfertilizer both are stationary at 1% level of significance in case both with the trend and without a trend.

Estimated equation of the total rice production

The estimated results of the model are tabulated in Table-4. The estimation model from the table can be written as

$$\text{Lntrp} = 0.267520\text{loan} + 0.006588\text{fertilizer}$$

The result of the multi-linear regression model has been presented in table 4. As the p-value of the variable Lnloan is significant, and the sign of the variable is positive, this indicates that Lnloan has a positive influence on rice production. On the other hand, as the p-value of variable Lnfertilizer is higher than 5%, so the variable is insignificant, but the sign of the variable is positive, meaning that the effect of chemical fertilizer on rice production is not statistically significant. If agricultural loan increases by 1%, then total rice production increases by 0.2675201%. As the sign of the variables are positive & 50% of the variables are significant, the model is good enough to proceed.

Table 4: Multi-linear regression model

Variable	coefficient	Std.error	t-statistic	prob
C	7.829051	0.912315	8.581525	0.0000
LNLOAN	0.267520	0.027774	9.631902	0.0000
LN FERTILIZER	0.006588	0.135029	0.048791	0.9616
R-squared	0.941725	Mean dependent var		10.17535
Adjusted R-squared	0.935590	S.D. dependent var		0.23692
SE of regression	0.060128	Akaike info criterion		-2.65855
Sum squared resid	0.068693	Schwarz criterion		-2.50977
Log likelihood	32.24409	Hannan-Quinn criter.		-2.62350
F-statistic	153.5193	Durbin-Watson stat		1.055009
Prob(F-statistic)	0.000000			

Moreover the R-square of the model is quite high. Here the value of R-square is 0.941725, it means that 94.17% of the variation in total rice production can be explained by loan-disbursement and chemical fertilizer and rest of the variation in total rice production can be explained other variables which are not included in the model.

Now to check the joint influence, then the following hypothesis has been checked.

Null: Inloan & Infertilizer do not jointly influence lntrp

Alt: Inloan & Infertilizer jointly influence lntrp

As the p-value of F-statistics is less than 5% so the null hypothesis has been rejected meaning that both variables has influence on total rice production.

Residual analysis of multi-linear model:

Residuals play a significant role in validating the regression mode. The residual analysis includes some test to be fulfilled like residuals are not serially correlated; there is no heteroscedasticity among the residuals and residuals are normally distributed.

Table 5: Results of the Heteroscedasticity Test

F-statistic	3.272692	Prob. F(2,19)	0.0601
Obs*R-squared	5.636965	Prob. Chi-Square(2)	0.0597
Scaled explained SS	3.961650	Prob. Chi-Square(2)	0.1380

Bruch-Pagan-Godfrey test has been conducted to detect heteroscedasticity in this study where the null hypothesis is: Residuals are not heteroscedasticity, which means residuals are homoscedasticity. From Table-5, it is clear that the null hypothesis has been accepted as the probability value is greater than 5% representing homoscedasticity of the residuals.

Now, the Breusch-Godfrey Serial Correlation LM Test has been conducted to find out the existence of serial correlation in this study. The null hypothesis of this test is that residuals are not serially correlated. The results of this test are shown in Table-6.

Table 6: Serial correlation

F-statistic	1.643210	Prob. F(2,17)	0.2226
Obs*R-squared	3.564021	Prob. Chi-Square(2)	0.1683

If the probability value is greater than 5%, we can't reject the null hypothesis. So from table 6, it is also clear that the null hypothesis has been accepted, meaning no autocorrelation in the residuals.

Now results of the normality test are shown in Figure-1. The null hypothesis of normality test is that residuals are normally distributed.

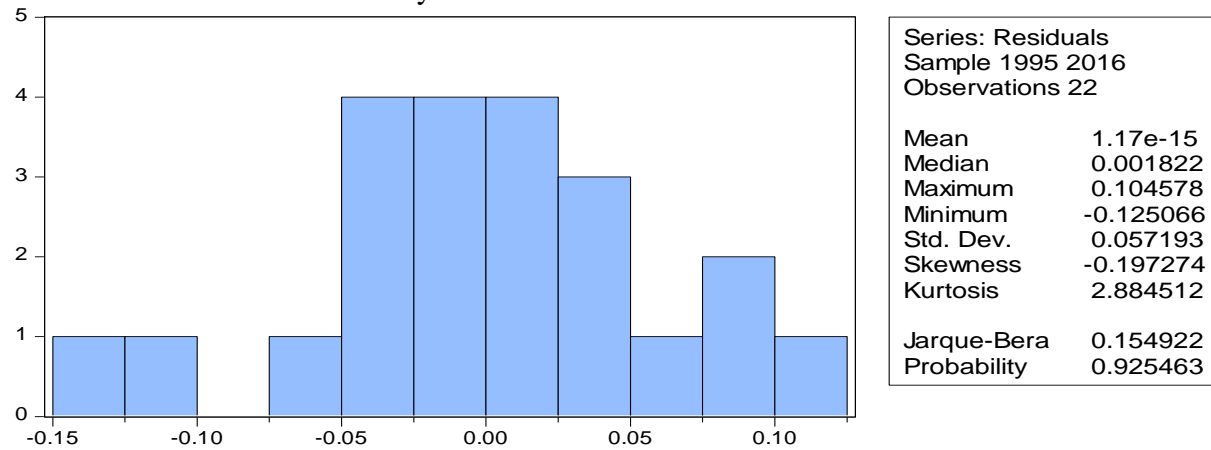


Figure 1: Normality Test

As the probability value of the Jarque-Bera test is more than 5%, so we can't reject the null hypothesis, which also confirmed that residuals are normally distributed.

We can detect multicollinearity by using variance inflating factor (VIF). Results of multicollinearity test are shown in Table-7

Table 7: Results of Multicollinearity test

Variable	VIF	1/VIF
Lnfertilizer	3.28	0.304716
Lnloan	3.28	0.304716
Mean VIF		3.28

According to Gujarati, DN (2003, 4th edition,pp-370), if the VIF of a variable exceeds 10 then that variable is said to be highly collinear. So from the above table, we see that there is no multicollinearity problem among the variables.

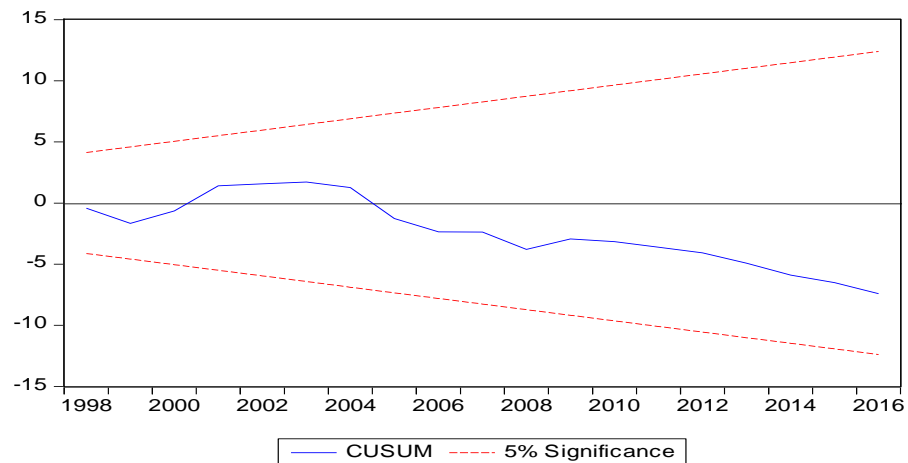


Figure 2: Stability Test

For the stability test of the dependent variable, CUSUM test has been performed. The dependent variable is stable if the blue line is located between the two red lines. Here we find that the blue line is between the two red lines meaning that our dependent variable is stable, which means total rice production is stable.

CONCLUSION AND RECOMMENDATION

Agriculture is the prime sector of Bangladesh's economy. It is the oldest but still a crucial sector for Bangladesh. The present study shows the influence of agricultural loan disbursement and chemical fertilizer on total rice production. And the study reveals that agricultural loan has a positive and statistically significant effect on total rice production while chemical fertilizer has a positive but statistically insignificant effect. The regression result confirms that if agricultural loan increases by 1%, then total rice production increases by 0.267520%.

Moreover, the study has fulfilled the necessary tests of residual analysis. Residuals in this study are not serially correlated; they are homoscedastic and normally distributed. From the stability test, the study has found that the dependent variable in the model is stable. The agricultural loan increases agricultural production; these findings support all literature cited here except Hussain (2012). Whereas the results of the insignificant effect of chemical fertilizer on agricultural production support the conclusions of Patra et al. (2016), Savci (2012), and Hussain (2012). However, the study focuses only on the impact of agricultural credit and chemical fertilizer on total rice production. Still, there are other variables like irrigation, cultivatable land area, seeds, etc., which affect rice production are not considered in the present case, and this is a limitation of the study, which paves the way for other research. Chemical fertilizer causes groundwater contamination as nitrates generated from nitrogen fertilizers can easily pass through the soil and can stay in groundwater. Groundwater contamination contributes to gastric, cancer, birth malformation, hypertension, testicular cancer, stomach cancer. Chemical fertilizer may cause respiratory ailments, 'methemoglobinemia,' which is called 'Blue Baby Syndrome.' So chemical fertilizer is not so conducive for health and environment, and that's why the study recommends supporting organic fertilizer, which is favorable for health, environment, and

agricultural production as well as will be helpful for the economic development of Bangladesh. And the study also recommends taking a more favorable agricultural loan disbursement policy to facilitate more agricultural loan disbursement than the present loan disbursement, which is prevailing at present both from institutional and non-institutional loan sources.

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