JEL: Q14, G21, O47

***Md. Sazzad Hossain Patwary*[1], *Md. Shahidul Islam*[2], *Rana Al Mosharrafa*[3]**

[1]*Begum Rokeya University*
[2]*University of Dhaka*
[3]*Prime University*
Bangladesh

EFFECT OF BANK CREDIT ON AGRICULTURAL GROSS DOMESTIC PRODUCT

Purpose. *This study aimed to provide the central bank of Bangladesh with some empirical data on the impact of bank agricultural credit on agricultural output as a priority sector lending.*

Methodology / approach. *Econometric analysis is applied to discover the nature of the relationship between banks' agricultural credit and agricultural gross domestic product (GDP) and to find the impact of bank agricultural credit on agricultural output in Bangladesh. Data are extracted from secondary sources, i.e., Bangladesh Bank, Bangladesh Bureau of Statistics, World Bank, and Ministry of Finance for 1991 to 2018. Time-series data are analyzed using the Augmented Dickey–Fuller (ADF) unit root test and the Johansen cointegration test and later examined with Vector Error Correction Model (VECM).*

Results. *The Augmented Dickey–Fuller unit root test confirmed that the variables were non-stationary at their level data and became stationary after taking their first difference value. Since the variables are integrated at I(1), we performed the Johansen Co-integration test. Subsequently, one co-integration equation was found, and Vector Error Correction Model estimation was done afterwards. According to the results of VECM estimation, bank agricultural credit, pesticide consumption, and use of cropped areas have long-run relation with agricultural output.*

Originality / scientific novelty. *This study reveals the nature of relationship and assessment of the impact of bank credit on agricultural GDP with empirically valid techniques and tools. In this context, the data from Bangladesh remains very rare. Moreover, for those works which have been done in the context of Bangladesh, appropriate methods and techniques are not always inherent. Hence, this significant research gap is addressed in our present study. Thus, we expect that the findings of this study from Bangladesh based on empirically valid standard techniques can incrementally contribute to the existing literature.*

Practical value / implications. *Findings of this research, can be used as an information basis by the central bank of Bangladesh. Based on the findings of this research, Bangladesh Bank should initiate new policies and programs regarding agricultural credit for the projected increase in agricultural GDP in Bangladesh.*

Key words: *agricultural GDP, agricultural credit, bank credit, agricultural production, VECM, Bangladesh.*

Introduction and review of literature. As a developing country, the agricultural sector in Bangladesh is considered the prime sector of the economy. The roots of the industrial sector have come from the agricultural sector, and the service sector has been passively supported by the rise of the agricultural sector. The share of agricultural sector in the total gross domestic product (GDP) of Bangladesh is currently 13.47 % (Bangladesh Economic Review, 2021). About 40.36 % of the country's total labour force is directly involved in this sector (Labor Force Survey, 2017). Foreign currency earning is now USD 1505.51 million from this sector (Export Statistics, 2021). In addition to the economic contribution, the agricultural sector also contributed to some social aspects, i.e., food supply, nutrition, poverty reduction, the standard of living, farmers' welfare and rural development.

Moreover, the environmental contribution of the agricultural sector to land, water, air, biodiversity and climate issue is equally important and should not be overlooked. The transition from developing to developed countries should ensure food security and a sustainable and environment-friendly agricultural production system. Therefore, the agricultural sector should pay attention and been given top priority by the government to ensure food security, poverty reduction and farmers' welfare in the light of Sustainable Development Goals, Delta Plan-2100, 7th Five Year Plan and National Agricultural Policy-2018 (Bangladesh Economic Review, 2021).

In Bangladesh, most of the farmers are small and marginal. About 84.27 % of the total farming household are small scale in nature (Agricultural Census, 2008). These small and marginal farmers have long faced a low-income level due to their low level of investment. Thus, low income turns into low consumption and saving, which ultimately forms poverty and low investment. Hence, capital formation is very necessary to break this vicious circle of poverty. So, bank agricultural credit in this regard is very important. Additionally, the food and nutrition needs of the vast population of the country are becoming a big challenge now due to gradual reduction of agricultural land. The increase in meeting demand while simultaneously reducing the crop area requires investment in improved inputs, i.e. improved seeds, pesticides and fertilizers. Similarly, agricultural activities are becoming more capital-intensive today. Hence, investment in modern equipment and machinery is also vital to improve agricultural productivity. Thus, farmers, especially small and marginal farmers, urgently need bank agricultural credits to invest in improved inputs and modern equipment. Furthermore, recurrent natural disasters and the global COVID situation have also affected Bangladesh's agricultural sector. Hence, protecting livelihoods of farmers, workers, and others involved in the agricultural sector has become the main challenge. In response to those challenges and the aforementioned requirements, affordable agricultural credits at a concessionary interest rate and subsidies on essential production inputs are needed to increase agricultural productivity.

In many developing countries, government interventions and policy modifications in the agricultural credit market are widely applied strategies to address increased agricultural production (Narayanan, 2016). Timely access and proper use of agricultural credit enable farmers to use agricultural inputs and investment, improving productivity of farmers, thus reducing poverty and facilitating their transformation from existence level farming to large-scale commercial farming (Carter, 1989; Feder et al., 1990; Foltz, 2004; Sakhno et al., 2019).

Considering the enormous importance of the agricultural sector and increased productivity, the Government of Bangladesh has been taking different initiatives to develop the formal agricultural credit market. Bangladesh Bank has announced agricultural credit as a priority sector lending. For the last fourteen years, Bangladesh Bank mandatorily incorporates all Private and Foreign Commercial Banks and State-Owned Commercial Banks in the agricultural credit programs to ensure the financial inclusion of the farmers. Previously in Bangladesh, BKB (Bangladesh Krishi Bank and RAKUB (Rajshahi Krishi Unnayan Bank) dominated the institutional formal agricultural credit market. Then State-owned Commercial Banks (SOCBs) are included to expand the financing net to the farmers. Finally, all private and foreign commercial banks participated in the agricultural credit market through NGO and MFIs linkage.

In 2021, targeted agricultural credit disbursement was BDT 262.9 billion, and actual disbursement was 255.1 billion, indicating more than 97 % of target achievement. On the other hand, the actual disbursement of banks' agricultural credit was BDT 227.5 billion in 2020, indicating a 12.13 % growth in actual disbursement in the last year (Bangladesh Bank Annual Report, 2021). In 2021, a total of 3055.166 thsd farmers had received agricultural loan of an amount of BDT 255.1 billion from six State-Owned Commercial Banks, two Specialized Banks (SBs), 39 Private Commercial Banks (PCBs) and eight Foreign Commercial Banks (FCBs) (Agricultural and Rural Credit Policy and Program, 2021).

Even though the indicators mentioned above regarding the bank agricultural credit flow and credit growth seem satisfactory and sufficient, it is difficult to assess impact of bank agricultural credits on agricultural output and the nature of their relationship. In this regard, the subsequent research questions were raised: What is the nature of the relationship between bank agricultural credits and agricultural gross domestic production? How do bank agricultural credits influence agricultural GDP? What is the nature of relationship among agricultural output and other factors affecting agricultural production? How do the other factors and bank agricultural credits influence agricultural production?

Turning to the answers of the above research questions, this section discusses some findings of previous empirical studies regarding agricultural credit and agricultural output to bring some evidence from the different regions of the world.

Rural credit had a quantifiable positive influence on India's agricultural output by analyzing data of districts from 1972–1973 to 1980–1981. In this study, the elasticity of cooperative credit for agricultural output was 0.063, which is higher than the elasticity of overall rural credit of 0.027 (Binswanger & Khandker, 1995). In Pakistan, bank agricultural credit is found positive and significant at the 5 % level, and the findings suggest that the bank credit to the agricultural sector has a positive effect on agricultural GDP. A 1 % increase in agricultural bank credit would increase by about 0.10 % of agricultural GDP (Iqbal et al., 2003). Generalized method of moments (GMM) reveals that the direct agricultural credit is positively described as the variation in agriculture production at a 5 % level of significance in India. While, the number of indirect agriculture credit accounts is positive at first lag and significant at 10 % (Das et al., 2009). Error Correction Model (ECM) based on time series data of Pakistan's economy for 1973–2009 demonstrated the long-run connection among variables, while the Granger causality test established unidirectional causality between agricultural bank credit and agricultural output and between irrigation and agricultural output (Sial et al., 2011). Another study demonstrated that federal agricultural expenditure on agricultural output had a positive coefficient of 0.4314 at a 10 % significance level, and agriculture credit had a negative direction at a 5 % significance level to output in Nigeria, which confirms that most agricultural credits are directed to other purposes (Iganiga & Unemhilin, 2011). The autoregressive distributed lag (ARDL) model confirms a positive relationship between agricultural credit and agricultural GDP as it is mainly used to purchase different inputs and indirectly influences the production level. In this model, the credit is statistically insignificant, having a coefficient of 0.12431, meaning a 10 % increase in bank credit will raise agricultural production by nearly 1.24 % (Ahmad, 2011).

Three simple linear regression models were used on the time series data of Nigeria from 1981 to 2009, and all these three models, namely the crop sector output-credit model, fishing sector output-credit model, and livestock sector output-credit model, confirm measurable positive and significant links between agricultural bank credit and the GDP of the said agricultural sub-sectors (Ammani, 2012). The area under cultivation and water availability had a positive and significant impact, and agricultural credit and fertilizer use had a positive but insignificant impact on rice production in Pakistan (Hussain, 2012). Bivariate Ordinary Least Square (OLS) regression estimation results revealed that agricultural credit from commercial banks to the agricultural sector and public financing to the agricultural sector significantly affected Nigeria's agricultural GDP. The connection between variables was found positive and significant. Therefore, agricultural bank credit of commercial banks to the agricultural sector and government financing for agriculture should be increased and monitored (Adofu et al., 2012). The long-run connection between the agricultural GDP and credit was positive for the Pakistani economy. The short-run credit elasticity on agricultural production was 0.0525, and the long-run credit elasticity was 0.198. Thus, in the short run, a 1 % increase in credit on average could increase agricultural GDP by 0.0525 %, and in the long run, it was 0.198 % (Awan and Mustafa, 2013). The linear regression model based on time series data from 1984 to 2007 in Nigeria revealed that the Agricultural Credit Guarantee Scheme (ACGS) and government budget allocation to agriculture had a significant, reliable, and positive effect on agricultural output (Obilor, 2013).

The OLS estimation results with 35 observations confirmed that foreign direct investment, loan from commercial banks, food import value, and interest rate are positively connected with agricultural production at a 5 % level of significance, while GDP growth rate unexpectedly negatively affected agricultural production (Kareem et al., 2013). Time series data of South Africa from 1970 to 2011 showed that bank agricultural credit and investment in agriculture had a long-term effect on agricultural

GDP and significant and positive results were found. In contrast, agricultural bank credit negatively impacts agricultural GDP in the short run (Chisasa & Makina, 2015). Thirty-four observations from the Nigerian economy's aggregated data revealed a positive link between the agricultural bank credit of commercial banks and agricultural output. A negative relationship was found between the rate of interest and agricultural GDP within the exact estimation, while Government expenditure showed a strong positive connection with agricultural GDP in the same model (Agunuwa et al., 2015).

Agricultural bank credit had a positive, albeit insignificant, effect on agricultural production. Agricultural inputs like fertilizers, pesticides, seeds, and tube-wells had 0.48 %, 0.44, 1.52, and 0.20 % positive effects correspondingly on agricultural output in Pakistan (Faridi et al., 2015). Increased institutional financing to the agricultural sector leads to increased agricultural inputs use. State-level panel data showed that credit flow significantly influences input purchase, whereas the agricultural GDP is not influenced by credit (Narayanan, 2016). Another study conducted in Pakistan, over the time series data from 1982 to 2011, found that credit repayment, water availability and area under wheat cultivation positively and significantly influence wheat production (Chandio et al., 2016). Vector Autoregression (VAR) estimation over the sample period of 1981–2013 in Nigeria showed that loans from commercial banks to the agriculture had a significant influence on agricultural GDP, while Agricultural Credit Guarantee Scheme Fund has an insignificant impact on agricultural GDP (Anetor et al., 2016). Time series data for 1981–2014 in Nigeria revealed that the bank long-term agricultural credit positively and significantly influences agricultural GDP, while this effect is insignificant for the short-term credit. In the long-run and short-run adverse effects of land and labour were found in agricultural GDP (Ogbuabor & Nwosu, 2017). Agricultural GDP is highly responsive to growth in bank agricultural credit and researchers found a unidirectional relationship between bank agricultural credit to agricultural GDP in Pakistan (Khan et al., 2017). ARDL Bound Testing Approach based on the annual time series data from 1973 to 2014 confirms a positive and significant relationship between agricultural credit and agricultural production in Pakistan. This study also indicates that agricultural output is also positively related with labor force and cropped area (Ahmad et al., 2018). A long-run significant relationship is found between bank credit and agricultural productivity in Nigeria. As analytical tools, the Augmented Dickey–Fuller (ADF) unit root test, Johannsen cointegration test and error correction model was deployed over the time series data from 1981 to 2017 (Emenuga, 2019). Assessment of the influence of some significant determinants of agricultural production, including agricultural credit in Pakistan based on the Cobb-Douglas production function, revealed that fertilizer, seeds, and bank agricultural credit had a substantial and positive influence on Agricultural GDP (Rehman et al., 2019). Panel dataset of different province from 2004 to 2014 using spatial panel model confirms Turkish agricultural GDP per hectare is increased by 0.17 % for a 1 % increase in agricultural credit (Koç et al., 2019). Agricultural Credit Guarantee Scheme Fund positively effects crop, livestock and fishery sector output with a positive and significant coefficient of 0.1607, 0.2320 and 0.2110 respectively in Nigeria (Reuben et al., 2020). Analysis of annual time series data from 1981–2018 applying unit root test, co-integration test and error correction model reveals food production in Nigeria increased by 0.002 to 0.006 % for a 1 % increase in farmers' access to agricultural credit (Osabohien et al., 2020). Time series data from 1998 to 2016 were analyzed through stationarity, cointegration test and further examined with Vector Error Correction Model (VECM) and OLS model. OLS regression for parameter detection revealed a 1 % increase in banks' agricultural credit disbursement leads a 0.045 % rise in agricultural GDP in Turkey (Bashi & Cetin, 2020).

The above-reviewed literature showed enormous empirical evidence of the impact of agricultural credit on agricultural production had been found from different regions of the world. Unfortunately, very few research studies have been done in Bangladesh regarding agricultural credit and productivity. If so, those existing research works about agricultural credit and productivity in Bangladesh only cover the correlation between credit and productivity and state the trends and growth in credit and productivity without considering the assessment of credit impact on productivity and identifying the nature of the relationship. Moreover, those works suffer from improper methods and techniques, and analysis based on the old dataset. Thus, this significant research gap is addressed in our present study by considering the impact assessment of credit on productivity and identifying the nature of the relationship between these two indicators. Furthermore, our analysis is based on the highest possible recent dataset and empirically valid new methods and techniques. Thus, we expect that the findings of this study based on empirically valid standard techniques with the new dataset from Bangladesh can incrementally contribute to the existing literature.

The purpose of the article. Hence, the following research objectives are specified for this study based on the previous research questions and empirical evidence. First, to identify the nature of relationship between bank agricultural credit and agricultural gross domestic production. Second, to estimate the effect and magnitude of bank agricultural credit on agricultural production. Third, to discover the pattern of association among agricultural output and other factors affecting agricultural production and bank agricultural credit. Fourth, to measure the elasticity of agricultural gross domestic product on other factors and bank agricultural credit.

Results and discussion. Annual time-series data from 1991 to 2018 is applied in this study. Bank agricultural credit along with other variables which influence agricultural production are considered for both impact assessment and nature of relationship identification among the variables. Data from 1991 to 2018 are considered since the uppermost published data for the variables considered in the study are available only from 1991 to 2018, thus, we have a total 28 number of observations. Data has been collected from different secondary sources, which are discussed in this section.

In many previous empirical studies we have found that different agricultural production inputs, i.e., agricultural labour force, agricultural land, irrigation, fertilizer, seeds, pesticides consumptions etc., have been considered as the independent variables to measure agricultural output. Moreover, some macro-economic variables, i.e., bank credit, agricultural budget, inflation, interest rate, foreign direct investment etc., are also considered by some authors in this regard. Unfortunately, in Bangladesh, consistent time series data are not available for most of the variables discussed earlier. Hence, the choice of the variables in our study depends on data availability. Therefore, in view of the availability of series data, we chose agricultural gross domestic product as the dependent variable. Meanwhile, agricultural labour force, consumption of pesticides, total cropped area and bank agricultural credit were selected as the independent variables because of data availability. Variable notation, brief description, measurement unit, data sources, and data publisher are furnished in Table 1.

Table 1

Variables and sources of data

Variable notation	Short description	Measurement unit	Sources of data	Publisher
AGDP	Agricultural Gross Domestic Product	Billion BDT	World Development Indicator–2020	World Bank (WB)
ACRED	Agricultural Bank Credit	Billion BDT	Annual Report–2020	Bangladesh Bank (BB)
LAB	Labor Force in Agricultural Sector	Million people	World Development Indicator–2020	World Bank (WB)
PES	Consumption of Pesticides	Thousand metric ton	Yearbook of Agricultural Statistics–2020	Bangladesh Bureau of Statistics (BBS)
CROP	Total Cropped Area	Thousand acres	Yearbook of Agricultural Statistics–2020	Bangladesh Bureau of Statistics (BBS)

Source: formed by the authors.

Before proceeding with any econometric analysis, it is essential to know the nature of the distribution of data series. In this study, we will consider descriptive statistics to obtain information about the normality of distribution, presence of any outliers, dispersion and central tendency. Kurtosis value measures the degree of sharpness, and skewness value measures the degree of symmetry in data distribution. Standard deviation, maximum and minimum value will provide statistics regarding dispersion. The mean and median value tells about the central tendency of data.

In this paper, the ADF unit root test was used to detect a unit root, whether the variables are stationary or not. Time-series data analysis requires knowing the stationarity level of data for further analysis. There are three models for the ADF unit root test, i.e., only intercept; trend, and intercept; no trend, and no intercept. This study used a unit root test with only an intercept model. The model is specified in equation (1) as follows (constant, no trend):

$$\Delta y_t = \alpha + \gamma y_{t-1} + v_t \quad , \qquad (1)$$

where Δy_t – the dependent variable at time t, which represents the change in the value of the dependent variable from the preceding time period;

α – the intercept term, which represents the constant change in the dependent variable that is not explained by any of the other terms in the model;

γy_{t-1} – the lag value of the dependent variable of the previous period, multiplied by the coefficient γ. This term conveys the persistence or momentum of the variable by indicating the extent to which its previous value influences its current value;

v_t – the error term at time t, which represents any unobserved or random influences on the dependent variable.

Additionally, after determining the variables' stationarity status, the Johansen cointegration test can be applied to assess the long-term equilibrium relationship among the variables. The establishment of any economic theory necessitates the presence of a long-run relationship among the variables. Hence, we can perform the co-integration test only when the variables become stationary at their first difference. In this study, a widely applied Johansen cointegration test has been performed. The trace and maximum eigenvalue statistics of the Maximum Likelihood method (ML) were used to detect the variables' co-integration rank. As a result, the general model can be defined as follows in equation (2):

$$\Delta X_t = \mu + \Phi D_t + \Pi X_{t-p} + \Gamma_{p-1} \Delta X_{t-p+1} + \ldots\ldots\ldots + \Gamma_1 \Delta X_{t-1} + \varepsilon_t , \quad (2)$$

where ΔX_t – the difference between the dependent variable X at time t and time t-1;

μ – the intercept term;

ΦD_t – a vector of deterministic variables, which are constants that are known and which may influence the dependent variable;

ΠX_{t-p} – a vector of lagged values of the dependent variable, where the lag index p ranges from 1 to a certain value. This term describes the influence of X's previous values on its current value;

$\Gamma_{p-1} \Delta X_{t-p+1}$ – a vector of lagged differences in the dependent variable, where the lag index p-1 ranges from 1 to a certain value. This term quantifies the influence of prior X changes on its current value;

$\Gamma_1 \Delta X_{t-1}$ – the lagged initial difference of X, which represents the short-term dynamics of X;

ε_t – the error term at time t, which accounts for any unobserved or random influences on X.

VECM is a restricted VAR model, suitable for variables with the unit root at their level value and becomes stationary after taking their first difference value. Additionally, The VECM can be performed only if at least one co-integration equation exists among the variables. Whilst, variables having no co-integration equation should go through the VAR model. This study will perform VECM estimation, which indicates whether the variables are associated with each other in the long-run or short-run. In equation (3), the error correction model has been presented:

$$A(L)\,\Delta y_t = \gamma + B(L)\,\Delta X_t + \alpha\,(y_{t-1} - \beta_0 - \beta_1 X_{t-1}) + v_t , \quad (3)$$

where $A(L)\,\Delta y_t$ – Δy_t represents the dependent variable, which is the change in the value of the variable of interest from the preceding time period as transformed by the lag operator A(L). This term describes the dynamic connection between the dependent variable and its previous values;

γ – the intercept term that indicates the constant change in the dependent variable that cannot be explained by any of the other model elements;

$B(L)\ \Delta X_t - \Delta X_t$ represents the exogenous variable, which is also changed by a lag operator B(L). This term describes the influence of an independent variable on an external variable;

$\alpha\ (y_{t-1} - \beta_0 - \beta_1 X_{t-1})$ – this term reflects the lagged dependent variable and the interaction between the lagged dependent variable and the lagged exogenous variable, both multiplied by coefficient *α*. This term describes the influence of past dependent and exogenous variable values on the current value of the dependent variable;

v_t – the error term at time t, which represents any unobserved or random influences on the dependent variable.

The following Figure 1 shows the trends and relationships of the variables over last 28 years.

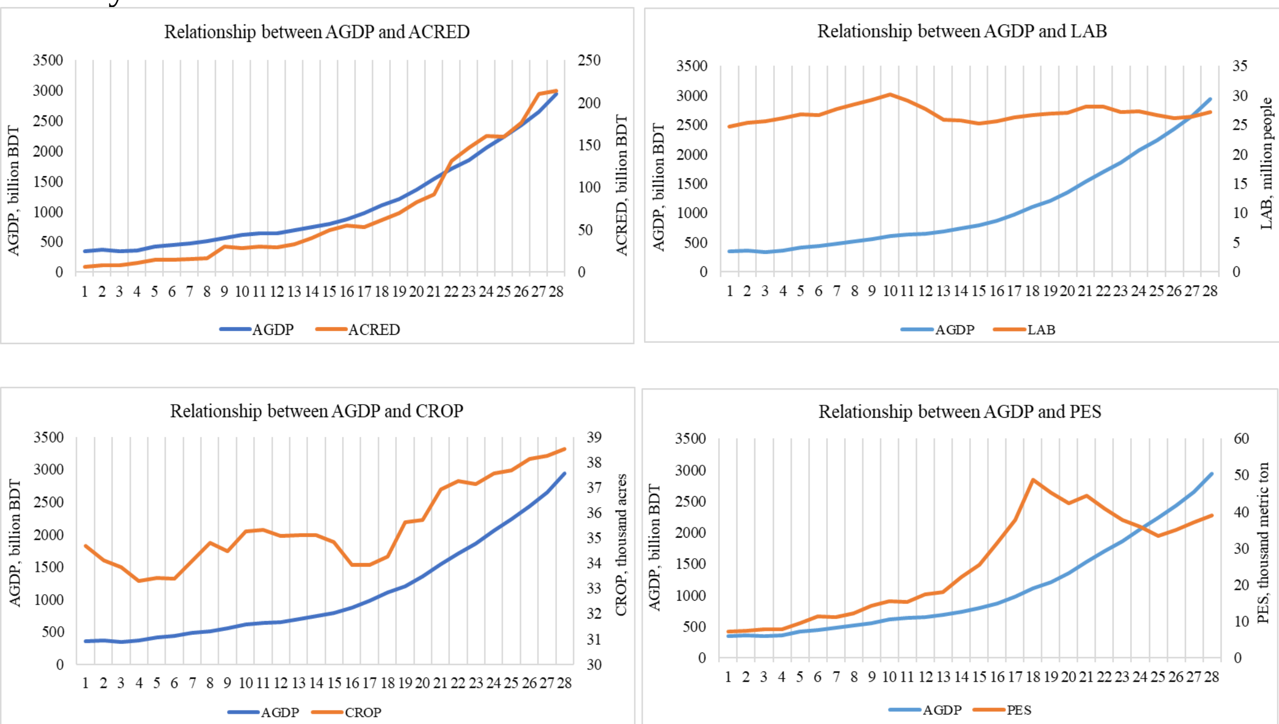

Figure 1. Trends of variables in Bangladesh, 1991–2018

Source: World Bank (WB), Bangladesh Bank (BB), Bangladesh Bureau of Statistics (BBS).

In the upper left corner of the figure, the relationship between AGDP and ACRED has been displayed. On the left y-axis is AGDP, and on the right y-axis is ACRED, which showed a positive relationship between AGDP and the ACRED variable over the past twenty-one years. Then for next four years, the curve showed an inverse relationship between these two variables. Afterwards we have found a positive trend for the last three years. Overall, the physical examination of the AGDP and ACRED curve revealed a long-run positive link, suggesting a strong relationship between these two variables except some short-run disequilibrium. The upper right corner of the figure, indicated an inverse relationship between AGDP and LAB variables over time. CROP variable showed an inconsistent trend in the lower left corner of the figure and exhibited a positive relationship with AGDP with some frequent short-run instability. Finally, the lower right corner of the figure, displayed a positive relationship between AGDP and PES variables over time except some short-term inverse relationship.

Results of descriptive statistics have been summarized in Table 2.

Table 2

Summary statistics

Variable	Observation	Maximum	Minimum	Mean	Median	Standard deviation	Skewness	Kurtosis
AGDP	28	2942.35	342.52	1103.35	765.80	776.59	0.96	2.69
ACRED	28	213.93	5.96	69.59	45.02	65.29	0.98	2.62
LAB	28	30.11	24.70	26.95	26.75	1.29	0.59	2.92
PES	28	48.69	7.18	25.42	23.79	14.01	0.09	1.45
CROP	28	38.53	33.31	35.42	35.10	1.61	0.57	2.05

Source: authors' calculation using EViews 11.

Table 2 displays the results of summary statistics which affirms that all the series data are consistent since all variables' mean and median values prevail with maximum and minimum values. Outcomes of skewness confirm a positive skewness of all variables in the desirable range of +3 to -3. Whilst results of kurtosis analysis indicate leptokurtic distribution of all variables and are within the acceptable range of +10 to -10. Results of ADF unit root tests of the analytical statistics are shown in Table 3.

Table 3

ADF unit root tests (only intercept)

Variable	At level		First difference	
	t-stat.	Critical values	t-stat.	Critical values
LnAGDP	1.402639	-3.711457 -2.981038 -2.629906	-3.330653**	-3.711457 -2.981038 -2.629906
LnACRED	-1.240040	-3.699871 -2.976263 -2.627420	-4.866245***	-3.737853 -2.991878 -2.635542
LnLAB	-2.490131	-3.711457 -2.981038 -2.629906	-2.888973*	-3.711457 -2.981038 -2.629906
LnPES	-1.620139	-3.711457 -2.981038 -2.629906	-3.275731**	-3.711457 -2.981038 -2.629906
LnCROP	0.238101	-3.699871 -2.976263 -2.627420	-4.248222***	-3.711457 -2.981038 -2.629906

Notes. ***, **, * correspondingly shows 1 %, 5 %, and 10 % significant level.
Source: authors' calculation using EViews 11.

From Column 1 of Table 3, we cannot reject the H_0: variables are not stationary. All t-statistics of variables do not reach their corresponding critical values.

Accordingly, we conclude that the time series data are not stationary at their level value. The second column shows the t-statistics and critical values of the variables at their first differences. Here, the t-statistics exceed their different critical values. Hence, we can accept the H_A: variables are stationary. Therefore, we found that all the variables become stationary after taking the variables' first difference value. Since, the variables are integrated at their first difference now we can perform the co-integration test.

Table 4 reported trace statistics and max statistics and their corresponding critical values. Trace statistics 96.97 > critical value 69.81 as well as max statistics 51.48 > critical value 33.87 in the hypothesized zero co-integration equitation. Therefore, we can reject the null hypothesis: there is no co-integration equation among the variables. At the hypothesized one co-integration equitation, trace statistics 45.48 < critical value 47.85 and max statistics 22.94 < critical value 27.58. Hence, the null hypothesis: there is one co-integration equation that cannot be rejected at this stage. Here, identifying one co-integration equation affirms the probability that a long-run equilibrium association prevails among the variables.

Table 4

Johansen cointegration test

Hypothesized no. of CE (s)	Trace stat.	5 % critical value	Max stat.	5 % critical value
None (r=0)*	96.97762	69.81889	51.48798	33.87687
At most 1	45.48964	47.85613	22.94130	27.58434

Notes. *rejection of the H_0 at 0.05 level.

Source: authors' calculation using EViews 11.

In the VECM estimation procedure, we set lag length and cointegration equation. Since Johansen cointegration test shows there is one co-integration equation and lag order selection criteria guided us optimal lag as one. The Least Squares (Gauss-Newton / Marquardt steps) method was applied in this VECM estimation. The system equation generated by the software was found as follows:

$$D(LNAGDP) = C(1) \cdot (LNAGDP(-1) - 1.4168 \cdot LNACRED(-1) + 0.9743 \cdot LNLAB(-1) + 0.5277 \cdot LNPES(-1) + 9.4537 \cdot LNCROP(-1) - 39.9534) + C(2) \cdot D(LNAGDP(-1)) + C(3) \cdot D(LNACRED(-1)) + C(4) \cdot D(LNLAB(-1)) + C(5) \cdot D(LNPES(-1)) + C(6) \cdot D(LNCROP(-1)) + C(7) \quad (4)$$

In equation 4, D(LNAGDP) is the explained variable. D(LNAGDP(-1), D LNACRED(-1), D(LNLAB(-1), D(LNPES(-1) and D(LNCROP(-1) are the explanatory variables in this estimation. Coefficient of cointegration equation is denoted as C(1) and C(2), C(3), C(4), C(5) and C(6) stands for the coefficient of D(LNAGDP(-1), D LNACRED(-1), D(LNLAB(-1), D(LNPES(-1) and D(LNCROP(-1) correspondingly.

The fundamental objective of VECM estimation is to inspect the dynamic behavior of the model and describe how it adjusts to each period towards its long-run equilibrium state. The coefficient of cointegration equation, also called coefficient of error correction term or error correction mechanism tells us about the speed of adjustment towards long-run equilibrium. The Error Correction Term (ECT) denotes the long-run assessment and the coefficient represents the parameter of ECT. If the value of coefficient is found statistically negative and its probability level is also found as below 0.05, thus it enables and admits a long-term connection among the variables (Chandio et al., 2020). Hence the basic requirements for VECM analysis comprise: (1) the coefficient of Error Correction Term must be lie between 0 and 1; (2) the coefficient must be negative; (3) the absolute value of t-statistics must be above 1.96, and (4) the probability value must be below 0.05.

Summary results of the VECM estimation of the analytical statistics are shown in Table 5. F-statistics value of 3.4072 and the probability value of 0.0187, which is less than 5 %, confirm this model's overall significance at a 5 % level of significance. Furthermore, the 0.5183 R-squared value affirms that the independent variables can describe a 51.83% variation of the dependent variable. Here, we have C(1) coefficient value as negative and lie between 0 to 1. The corresponding probability value is less than 1 % and the absolute value of t-statistics is greater than 1.96. Therefore, all the criteria of VECM analysis are met, which verifies the presence of long-run relationship among the variables. Thus, we can conclude that in the long-run agricultural GDP is influenced by bank agricultural credit, labour use, pesticide consumption and use of the cropped area.

Table 5

Summary results of VECM estimation

Indicator	Coefficient	Std. error	t-stat.	Prob.
C(1)	-0.1506	0.0400	-3.7633	0.0013
C(2)	-0.2272	0.2542	-0.8937	0.3827
C(3)	-0.0282	0.0505	-0.5594	0.5824
C(4)	0.4608	0.2935	1.5696	0.1330
C(5)	-0.0964	0.0717	-1.3436	0.1949
C(6)	1.1534	0.6639	1.7371	0.0985
C(7)	0.1024	0.0200	5.1004	0.0001
R-squared	0.5183	F-stat.		3.4072
Adjusted R-squared	0.3661	Prob(F-stat.)		0.0187

Source: authors' calculation using EViews 11.

In our results, we have the coefficient of error correction term C (1) as -0.1506. The implication of the result is that around 15.06 % of errors that occurred within the period are corrected in following periods. In other word the adjustment coefficient is -0.1506, it means that currently, about 15.06 % of the short-run disequilibrium errors can converge to produce a long-run equilibrium relationship. This means that the errors in the system are short-lived and the result is reliable, and the resulting long-term relationships can be maintained. Similar outcomes are found by Obioma et al. (2021) in Nigeria, and Hassan (2017) in Pakistan where the authors found coefficient of error correction term as -0.1862 and -0.1407 respectively. Our results are also similar with the findings of most recent research work done by Abdulrafiu & Dabo (2022) in Nigeria, and Nascimento et al. (2022) in Brazil, where a long-run relationship is found between agricultural sector production and credit from financial institutions. However, our results are contradictory with the findings of Khan et al. (2017) in Pakistan, and Ngong et al. (2020) in Central Africa, where the authors found insignificant and weak speed of adjustment rate as 0.60 and 0.76 % respectively.

Based on the findings, the study recommends some policy implications to the respective authorities: First, Bangladesh Bank should increase the flow of bank agricultural credit and ensure the judicious use of credit by implementing new regulations, programs, products, and funding policies as well as expanding the banking network to the rural areas. Second, Ministry of Agriculture should ensure the timely flow of direct production inputs i.e. pesticides and the integrity regarding input subsidy distribution. Third, the Ministry of Land should take care of the protection of cropped areas from unplanned housing and industrialization.

Conclusions. This paper examines the nature of the relationship among bank agricultural credit and some other influencing factors of agricultural production to agricultural GDP in Bangladesh. Some theoretical assumptions are hypothesized and later analyzed with descriptive and analytical statistics based on past empirical studies. Different econometric estimations were carried out in the analytical part. Due to data availability, data for the last 28 years was used.

The ADF unit root test affirms that the variables were non-stationary at their level data and became stationary after taking their first difference value. Since the variables are integrated at I(1), we performed the Johansen cointegration test. Subsequently, one cointegration equation was found, and VECM estimation was done afterwards. VECM estimation found that agricultural GDP is significantly influenced by banks' agricultural credit, pesticide use, labour use, and cropped areas in the long run. The coefficient of error correction term was found as -0.1506 and statistically significant thus the magnitude indicates there is a convergence in the long run at an adjustment speed of 15.06 % yearly, contributed by the explanatory variables to explain our dependent variable agricultural production.

In a developing country, government monetary policy is critical to managing lending to priority sectors. Thus, the public policy maker needs empirical evidence of the connection between agricultural bank credit and agricultural production. Given this, the paper inspects the nature of relationship between the bank agricultural credit and agricultural GDP. Simultaneously, other influencing factors of agricultural GDP, i.e. inputs of agricultural production, were also examined for the same purpose and for considering the input subsidy issue.

In this paper, due to data unavailability, we enforced to use a limited range of data. For the same reason, we also considered some limited variables. Besides, this analysis based on secondary data certainly has some limitations. Therefore, the obtainability of some other input and data of macroeconomic variables for an extended period may create a new avenue for future research. Moreover, it is also vital to assess bank agricultural credit's effect on agricultural output by using primary data. We hope that future research on micro-level data will create more opportunities to present new research results to the government to change the policy of agricultural credit and agricultural development.

References

1. Adofu, I., Abula, M., & Agama, J. E. (2012). The effects of government budgetary allocation to agricultural output in Nigeria. *Sky Journal of Agricultural Research*, 1(1), 1–5.

2. Abdulrafiu, T. & Dabo, A. C. (2022). Impact of agricultural finance on agricultural output in Nigeria (1983–2018). https://doi.org/10.2139/ssrn.4201333.

3. Agricultural and Rural Credit Policy and Program (2021). Bangladesh Bank, Ministry of Finance, Government of the People's Republic of Bangladesh. Available at: https://www.bb.org.bd/en/index.php/publication/publictn/0/45.

4. Agricultural Census (2008). Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh. Available at: http://data.gov.bd/dataset/agriculture-census-2008/resource/3074340b-1519-44af-bf48-a38ec7d71a2b.

5. Agunuwa, E. V., Inaya, L., & Proso, T. (2015). Impact of commercial banks' credit on agricultural productivity in Nigeria (time series analysis 1980–2013). *International Journal of Academic Research in Business and Social Sciences*, 5(11), 337–350. https://doi.org/10.6007/ijarbss/v5-i11/1921.

6. Ahmad, D., Chani, M. I., & Afzal, M. (2018). Impact of formal credit on agricultural output: empirical evidence from Pakistan. *Sarhad Journal of Agriculture*, 34(3), 640–648. https://doi.org/10.17582/journal.sja/2018/34.3.640.648.

7. Ahmad, N. (2011). Impact of institutional credit on agricultural output: a case study of Pakistan. *Theoretical and Applied Economics*, 18(10), 99–120. Available at: http://store.ectap.ro/articole/653.pdf.

8. Ammani, A. A. (2012). An investigation into the relationship between agricultural production and formal credit supply in Nigeria. *International Journal of Agriculture and Forestry*, 2(1), 46–52. https://doi.org/10.5923/j.ijaf.20120201.08.

9. Anetor, F., Ogbechie, C., Kelikume, I., & Ikpesu, F. (2016). Credit supply and agricultural production in Nigeria: a vector autoregressive (VAR) approach. *Journal of Economics and Sustainable Development*, 7(2),131–143. Available at: https://core.ac.uk/download/pdf/234647384.pdf.

10. Awan, F., & Mustafa, U. (2013). Key factors contributing to agricultural growth in Pakistan: an application of time series analysis. *Journal of Agricultural Economics and Development*, 1(2), 6–13. http://www.academeresearchjournals.org/journal/jaed/archive/january-2013-vol.-2-(1).

11. Bahşi, N., & Çetin, E. (2020). Determining of agricultural credit impact on agricultural production value in Turkey. *Ciência Rural*, 50(11), 1–13. https://doi.org/10.1590/0103-8478cr20200003.

12. Bangladesh Bank Annual Report (2021). Bangladesh Bank, Ministry of Finance, Government of the People's Republic of Bangladesh. Available at: https://www.bb.org.bd/en/index.php/publication/publictn/0/2.

13. Bangladesh Economic Review (2021). Finance Division, Ministry of

Finance, Government of the People's Republic of Bangladesh. Available at: https://mof.portal.gov.bd/site/page/28ba57f5-59ff-4426-970a-bf014242179e/Bangladesh-Economic-Review-2021.

14. Binswanger, H. P., & Khandker, S. R. (1995). The impact of formal finance on the rural economy of India. *The Journal of Development Studies*, 32(2), 234–262. https://doi.org/10.1080/00220389508422413.

15. Carter, M. R. (1989). The impact of credit on peasant productivity and differentiation in Nicaragua. *Journal of Development Economics*, 31(1), 13–36. https://doi.org/10.1016/0304-3878(89)90029-1.

16. Chandio, A. A., Jiang, Y., Rauf, A., Ahmad, F., Amin, W., & Shehzad, K. (2020). Assessment of formal credit and climate change impact on agricultural production in Pakistan: a time series ARDL modeling approach. *Sustainability*, 12(13), 5241. https://doi.org/10.3390/su12135241.

17. Chandio, A. A., Jiang, Y., Joyo, M. A., & Rehman, A. (2016). Impact of area under cultivation, water availability, credit disbursement, and fertilizer off-take on wheat production in Pakistan. *Journal of Applied Environmental and Biological Sciences*, 6(10), 10–18. Available at: https://www.textroad.com/JAEBS-October,%202016.html.

18. Chisasa, J., & Makina, D. (2015). Bank credit and agricultural output in South Africa: cointegration, short-run dynamics, and causality. *Journal of Applied Business Research*, 31(2), 489–500. https://doi.org/10.19030/jabr.v31i2.9148.

19. Das, A., Senapati, M., & John, J. (2009). Impact of agricultural credit on agriculture production: an empirical analysis in India. *Reserve Bank of India Occasional Papers*, 30(2), 75–107.

20. Emenuga, P. E. (2019). Effect of commercial banks' credit on agricultural productivity in Nigeria. *Acta Universitatis Danubius*, 15(3), 417–428.

21. Export Statistics (2021). Export Promotion Bureau, Ministry of Commerce, Government of the People's Republic of Bangladesh. Available at: http://www.epb.gov.bd.

22. Faridi, M. Z., Chaudhry, M. O., & Tahir, N. (2015). Institutional credit and agricultural productivity: evidence from Pakistan. *Pakistan Journal of Life and Social Sciences*, 13(3), 183–188. Available at: https://www.pjlss.edu.pk/pdf_files/2015_3/183-188.pdf.

23. Feder, G., Lau, L. J., Lin, J. Y., & Luo, X. (1990). The relationship between credit and productivity in Chinese agriculture: a microeconomic model of disequilibrium. *American Journal of Agricultural Economics*, 72(5), 1151–1157. https://doi.org/10.2307/1242524.

24. Foltz, J. D. (2004). Credit market access and profitability in Tunisian agriculture. *Agricultural Economics*, 30(3), 229–240. https://doi.org/10.1111/j.1574-0862.2004.tb00191.x.

25. Hassan, M. R. (2017). The impact of financial sector development on agricultural growth: empirical evidence from Pakistan. *Market Forces*, 12(2), 1–11. Available at:

https://kiet.edu.pk/marketforces/index.php/marketforces/article/view/340.

26. Hussain, A. H. (2012). Impact of credit disbursement, area under cultivation, fertilizer consumption, and water availability on rice production in Pakistan (1988–2010). *Sarhad Journal of Agriculture*, 28(1), 95–101.

27. Iganiga, B. O., & Unemhilin, D. O. (2011). The impact of federal government agricultural expenditure on agricultural output in Nigeria. *Journal of Economics*, 2(2), 81–88. https://doi.org/10.1080/09765239.2011.11884939.

28. Iqbal, M., Ahmad, M., Abbas, K., & Mustafa, K. (2003). The impact of institutional credit on agricultural production in Pakistan. *The Pakistan Development Review*, 42(4), 469–485. https://doi.org/10.30541/v42i4iipp.469-485.

29. Kareem, R. O., Bakare, H. A., Raheem, K. A., Ologunla, S. E., Alawode, O. O., & Ademoyewa, G. R. (2013). Analysis of factors influencing agricultural output in Nigeria: macro-economics perspectives. *American Journal of Business, Economics, and Management*, 1(1), 9–15. Available at: http://www.openscienceonline.com/journal/archive2?journalId=709&paperId=109.

30. Khan, W., Fatima, S., & Jamshed, M. (2017). Agricultural credit-led agricultural growth: a VECM approach. *Asian Journal of Agricultural Extension, Economics and Sociology*, 19(1), 1–16. https://doi.org/10.9734/AJAEES/2017/32304.

31. Koç, A. A., Yu, T. E., Kıymaz, T., & Sharma, B. P. (2019). Effects of government supports and credits on Turkish agriculture: a spatial panel analysis. *Journal of Agribusiness in Developing and Emerging Economies*, 9(4), 391–401. https://doi.org/10.1108/JADEE-11-2018-0164.

32. Labor Force Survey (2017). Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh.

33. Narayanan, S. (2016). The productivity of agricultural credit in India. *Agricultural Economics*, 47(4), 399–409. https://doi.org/10.1111/agec.12239.

34. Nascimento, D. H., Carrasco-Gutierrez, C. E., & Schneid Tessmann, M. (2022). Rural credit and agricultural production: empirical evidence from Brazil. *International Journal of Finance & Economics*. https://doi.org/10.1002/ijfe.2648.

35. Ngong, C. A., Thaddeus, K. J., & Onwumere, J. U. (2020). Banking sector development and agricultural productivity in Central African economic and monetary community (CEMAC). *Journal of Agricultural Science and Technology*, 10(2), 68–82. https://doi.org/10.17265/2161-6264/2020.02.002.

36. Obilor, S. I. (2013). The impact of commercial banks' credit to agriculture on agricultural development in Nigeria: an econometric analysis. *International Journal of Business, Humanities, and Technology*, 3(1), 85–94. Available at: https://www.ijbhtnet.com/journals/Vol_3_No_1_January_2013/11.pdf.

37. Obioma, I. F., Ihemeje, J. C., Ogbonna, C. I., Amadi, C. O. & Hanson, U. E (2021). Effect of agricultural financing on the performance of agricultural sector in Nigeria. *Journal La Bisecoman*, 2(2), 1–13. https://doi.org/10.37899/journallabisecoman.v2i2.360.

38. Ogbuabor, J. E., & Nwosu, C. (2017). The impact of deposit money bank's agricultural credit on agricultural productivity in Nigeria: evidence from an error

correction model. *International Journal of Economics and Financial Issues*,7(2), 513–517. Available at: https://dergipark.org.tr/en/download/article-file/365910.

39. Osabohien, R., Adeleye, N., & De Alwis, T. (2020). Agro-financing and food production in Nigeria. *Heliyon*, 6(5), e04001. https://doi.org/10.1016/j.heliyon.2020.e04001.

40. Rehman, A., Chandio, A. A., Hussain, I., & Jingdong, L. (2019). Fertilizer consumption, water availability, and credit distribution: major factors affecting agricultural productivity in Pakistan. *Journal of the Saudi Society of Agricultural Sciences*, 18(3), 269–274. https://doi.org/10.1016/j.jssas.2017.08.002.

41. Reuben, J., Nyam, C. M., & Rukwe, D. T. (2020). Agricultural credit guarantee scheme fund and its effect on agricultural output in Nigeria. *Review of Agricultural and Applied Economics*, 23(2), 102–111. https://doi.org/10.15414/raae.2020.23.02.102-111.

42. Sakhno, A., Polishchuk, N., Salkova, I., & Kucher, A. (2019). Impact of credit and investment resources on the productivity of agricultural sector. *European Journal of Sustainable Development*, 8(2), 335–345. https://doi.org/10.14207/ejsd.2019.v8n2p335.

43. Sial, M. H., Awan, M. S., & Waqas, M. (2011). Institutional credit and agricultural production nexus. *International Journal of Business and Social Science*, 2(13), 279–284. Available at: http://ijbssnet.com/view.php?u=http://ijbssnet.com/journals/Vol._2_No._13_Special_Issue_July_2011/33.pdf.

Citation:

Стиль – ДСТУ:

Patwary M. S. H., Islam M. S., Mosharrafa R. A. Effect of bank credit on agricultural gross domestic product. *Agricultural and Resource Economics*. 2023. Vol. 9. No. 1. Pp. 188–204. https://doi.org/10.51599/are.2023.09.01.09.

Style – APA:

Patwary, M. S. H., Islam, M. S., & Mosharrafa, R. A. (2023). Effect of bank credit on agricultural gross domestic product. *Agricultural and Resource Economics*, 9(1), 188–204. https://doi.org/10.51599/are.2023.09.01.09.