Bridging Finance and Farming: Evidence on the Association between Financial Inclusion and Agricultural Performance in Southwest Bangladesh

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Abstract

The objective of this study is to investigate the association of financial inclusion on agricultural output in the research region. Meherpur Sadar in the Meherpur district and Chuadanga Sadar in the Chuadanga district comprise the two upazilas that form the research area. A systematic random sample strategy is used to gather data from 100 farmers who live in this area. The data, which includes information on agricultural production and farmers' opinions on several facets of financial inclusion, is collected in both continuous and categorical forms. The elasticity of output and marginal product of the physical inputs needed for agricultural production are estimated using the translog production function. The farmers' opinions on the advantages of financial inclusion in their farming operations are also ascertained by principal component analysis. The study's conclusions show that having a bank account and having credit access facilities have a significant association with agricultural productivity. Additionally, the data shows that fertilizer produces higher marginal productivity, while labor exhibits a greater level of output elasticity in relation to seed, fertilizer, and pesticide. Additionally, the use of pesticides and fertilizers together improves output. The qualitative research shows that financial inclusion improves output and lowers farmer poverty. However, the lack of sufficient collateral to sustain bank loans is a significant obstacle. Expanding banking facilities in rural regions under appropriate supervision can successfully address these issues.

Keywords: Financial Inclusion, Trans-log Production Function, Farmers' Perception, Agricultural Productivity, and Bangladesh's Southwest Region

1. Introduction

Bangladesh is mainly an agriculture-based country, and agriculture sector contributes to a great extent to our economy. The agricultural sector acts as a catalyst to alleviate poverty through creating employment opportunities.[1] Most of the people lives in rural areas of Bangladesh directly or indirectly depend on agriculture for their livelihood.[2] Farmers of our country are not in a convenient position financially. As a result, to get credit, they have to depend on institutional and non-institutional sources for credit. Sometimes they use credit for consumption and other purposes rather than using it in farming activities.[3]Financial inclusion is increasing due to the growing number of

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banking institutions. It is important to gather information on the purposes farmers are using credit or financial resources and how financial inclusion affects agricultural production.[4] Farmers with access to institutional agricultural finance can assist the growth of agricultural production. Consequently, proper use of financial resources may bring about optimistic change in agricultural production.[5] Finance is a dominant instrument of economic growth, particularly in Bangladesh which is a developing country. The poor need financial access for eradicating poverty and advancing inclusive economic growth in the country.[6] Generally, this access to financial resources is known as financial inclusion. More precisely, it is the procedure of assuring access to opposite financial products and services required by all parts of society, especially for vulnerable low-income groups, at an affordable cost and in a fair, transparent manner through regulated formal financial institutions.[7] There exists an increasing indication of the positive and significant association of access to financial services on every facet of economic and social outcomes, both in firm and household levels.[8, 9] Any type of activity related to production requires financing.

Without relationship and appropriate financing, it is not possible to maximize output from the production process. In this sense, agricultural sector requires sufficient financial resources for enhancing production. Bangladesh Bank has instructed every commercial and state-owned bank to disburse at least 2% of their total credit sanction as agricultural sector to increase financial services in agriculture[10]. In accordance with the Agricultural and Rural Credit Policy and Program 2014-15, BB targeted to extend credit facility to attain the expected level of agricultural production and to promote financial inclusion.[10] Farmers with access to institutional agricultural finance can facilitate the growth of agricultural production.[11] Since our farmers are very poor sometimes, they use agricultural finance of government in consumption purpose.[2]

Hence, there may be mixed results of financial inclusion on agricultural development.[12] Taking these issues under consideration this study tries to examine whether raised financial services access can bring about change in agricultural production. To attain this target this study finds if the inclusion of finance in agricultural sector can be an efficient strategy to enhance production. Information about production which is financed through bank account helps to facilitate this work. Farmers' perceptions of the accessibility and effectiveness of financial inclusion in agricultural production help to understand their behavior in utilizing financial services and benefits provided by formal financial institutions, particularly banks. This study tries to explore its objective through evaluating farmers and assessing the relationships of financial inclusion on agricultural production. However, studies concentrating on the southwest region of Bangladesh which reflect the association of financial inclusion on agricultural sector in Bangladesh remain rare. This study has made an effort to address these issues which can assist further policy implications and development of the agriculture of this area.

2. Literature Review

The process of gaining required financial services, at a reasonable price, at the right place, through a formal intermediary and without discrimination against the populace is

known as financial inclusion.[13] In other words, it refers to the process of assuring accessibility to relevant financial services and products required by all individuals of the society, particularly the vulnerable low-income groups, at an affordable cost fairly and transparently, by regulated conventional financial institutions.[7]In the same way, financial inclusion can be defined as the route that ensures the simplicity of access, availability, and usage of a recognized financial system for each and every member of an economy.[14] It indicates access to financial services by mass people, especially the financially underprivileged.[15, 16] It is the procedure by which financial resources are mobilized and utilized in the economy[6]. In Bangladesh, the formal sector has grown in recent years in distributing agricultural credit, whereas the informal sector dominated the rural agricultural credit market in the past[17], a moderate 16% of the cultivators get credit from formal sources like banks.[18] Due to a lack of savings facilities, farmers have to count on inefficient, inconvenient and expensive alternatives.[2] To solve this problem, Bangladesh Bank (BB) has taken some innovative steps, such as, instructing all commercial and state-owned banks to disburse a minimum 2% of their total credit sanction as agricultural credit; and it helps to increase financial services in agriculture to attain the expected level of agricultural production and to promote financial inclusion.[10] All scheduled financial intermediaries under the supervision of the BB are required to offer different short and long-term credit opportunities to the agricultural sector, and about 63% of credit is disbursed as short-term lending and the remaining 37% as long-term loans.[19]

There are many problems in the case of agricultural financing. Non-government organizations (NGOS) and microfinance institutions (MFIS) charge a huge amount of interest to the farmers[20], which is absent in commercial and private banks of Bangladesh.[21] Formerly, there were numerous evidences on exclusion of interest rate for agricultural credit through political favor, therefore farmers waited for further chances and delay to repay their loans.[22]Though small and marginal farmers comprise 80% of the farming people in Bangladesh, only 17% of the small farmers have straight access to institutional credit.[17]

In our country, banking deposits mobilizing from rural areas are channeled into institutional credit operations to major urban areas. The credit-deposit ratio in the urban areas of Bangladesh is approximately 85% whereas in rural areas it is 75% [17] and it creates problems in rural agricultural financing Sometimes, farmers take loans screening that as an investment into agricultural activities but actually putting that into social expenses.[23] Besides, farmers have lack of basic knowledge of financing.[13]

Translog production function has been used to determine the marginal returns of variable inputs used in agricultural production[24], translog stochastic frontier production to calculate technical efficiency.[25] Translog production functions has also been used to determine the degrees of capital-labor substitution in agriculture and fishing, manufacturing industries and some other sectors.[26] Translog production function is estimated to examine elasticity of substitution amongst electricity, labor and capital in manufacturing industry.[27] Principal component analysis (PCA) used to study the factors affecting the advantage of agricultural research programs.[28] Another study implemented

PCA to find out those factors liable for differences in farmers' farming practices.[29] This tool is also used to find out principal components in analyzing discrete data.[30]

Financial inclusion in the agricultural sector can attain the desired level of development of this sector and it also leads to poverty alleviation.[31] There is evidence of a highly positive correlation between the availability of agricultural credit and greater production.[21] Timely and convenient access to credit enables farmers to afford the required inputs and equipment for carrying out farm operations and enhancing production.[4]

Very few remarkable studies have assessed the relationships of financial inclusion on agriculture, especially in the South-west region of Bangladesh. This study investigates whether increased access to financial services can lead to a transformation in agricultural production. The utilization of bank accounts to finance production provides valuable information that facilitates this examination. Additionally, understanding farmers' perceptions regarding the accessibility and relationships of financial inclusion in agricultural production contributes to a comprehensive understanding of this matter. Although there have been some studies on the association of financial inclusion on agriculture in Bangladesh, there is a scarcity of research focusing on the south-west region of the country. Therefore, this study aims to address these gaps in knowledge, which can inform future policy implications and contribute to the development of the agricultural sector in this particular area.

3. Materials and Methods

3.1 Study Area

This research focuses on how financial inclusion affects the agricultural sector of the South-west region of Bangladesh. Meherpur Sadar in Meherpur district and Chuadanga Sadar in Chuadanga district comprise the two upazilas that form the research area. From these study areas, respondents having a bank account and respondents having credit facility through that bank account are selected purposively. This study considers 100 respondents for analysis which is distributed equally between two upazilas. The research employs a systematic random selection strategy to select farm homes from the study area. However, farmers who were financially included were only partially identified by purposive selection to ensure that persons with access to formal financial services were adequately represented. This strategy allows you to focus more carefully on financial inclusion, but it may also introduce selection bias, making the results less helpful in other contexts.

3.2 Data and Variables

This research is mainly based on primary data. Data about socio-economic features like age, sex, educational qualification, income, expenditure, farming assets etc., are collected from 100 farmers by surveying through an interview schedule. Data regarding behavioral characteristics of farmers and how financial inclusion affects agricultural growth are also collected by following same method. These data comprise access of bank accounts, availability of agricultural credit from bank, amount of credit taken, rate of

interest, number of installments, purpose of utilizing credit, and amount of seasonal agricultural production. The survey with a structured questionnaire was conducted in the 2nd half of the year 2025 (i.e., July to December). Other necessary data is collected from different secondary sources.

TABLE 1: Variables in Estimating Production Function.

Variables	Description	Unit	Expected Signs	Related Literature
Y	Agricultural production	Maund per bigha	N/A	Hasan et al. (2013)
N	Amount of labor used	Man days per bigha	(+)	Hasan et al. (2013)
Sd	Amount of seed sown	Kg per bigha	(+)	Hasan et al. (2013)
F	Amount of fertilizer used	Kg per bigha	(+)	Hasan et al. (2013)
P	Amount of pesticide used	Kg per bigha	(+)	Hasan et al. (2013)
Ag	Farmer's age	Year	(+)	Author's Compilation (2025)
Lt	Farmer's literacy level	Year of schooling	(+)	Author's Compilation (2025)
Bank	Having bank account	Dummy(1=Yes, 0- No)	(+)	Author's Compilation (2025)
Credit	Amount of credit taken from bank	BDT	(+)	Author's Compilation (2025)
Maund-37.32 kg, bigha= 0.33acre, N/A = Not applicable				

Source: Authors' Compilation, 2025

Table 1 represents the explanation of the variables in estimating production function. Variable symbols, description of the variables, their unit of measurement, expected sign and related literature are presented in the table. Agricultural production (output) is the dependent variable and measured in Maund per bigha which shows the farm's productivity. Other variables are independent variables having positive expected sign. Furthermore, variables related to financial inclusion were included in the model to assess their direct and indirect effects on agricultural productivity. These variables reflect farmers' access to formal financial services, which may facilitate investment in modern inputs, technology adoption, and efficient farm management. The inclusion of socioeconomic and institutional factors allows for a more robust estimation of the determinants of agricultural production.

3.3 Empirical Analysis

3.3.1 Estimating Production Function

Translog production function is also known as transcendental logarithmic production function and is frequently used in production analysis. This function has both linear and

quadratic terms having ability of applying more than two factor inputs and used in different studies.[32, 24, 27, 25, 26]

In analyzing production most of them determine output elasticity of inputs and marginal product of those inputs. This study also uses translog function of production to estimate the relationships of agricultural factors and financial inclusion on agricultural production.

$$\begin{aligned}\ln Y = {} & \beta_0 + \beta_N \ln N + \beta_{Sd} \ln Sd + \beta_F \ln F + \beta_P \ln P + \beta_{Ag} \ln Ag + \beta_{Lt} \ln Lt + 1/2\, \beta_{NN} (\ln N)^2 \\ & + \beta_{Nsd} \ln N \ln Sd + \beta_{NF} \ln N \ln F + \beta_{NP} \ln N \ln P + 1/2\, \beta_{SdSd} (\ln Sd)^2 \\ & + \beta_{SdF} \ln Sd \ln F + \beta_{SdP} \ln Sd \ln P + 1/2\, \beta_{FF} (\ln F)^2 + \beta_{FP} \ln F \ln P \\ & + 1/2\, \beta_{pp} (\ln P)^2 + 1/2\, \beta_{Ag2} (\ln Ag)^2 + 1/2\, \beta_{Lt2} (\ln Lt)^2 \\ & + \beta \mathrm{Bank}\ \mathrm{Bank} + \beta \mathrm{Crdt}\ \mathrm{Crdt} + \varepsilon \quad \ldots (1)\end{aligned}$$

Where Y, N, Sd, F, P, Ag, Lt, Crdt, Bo and & denote agricultural output or production, labor, seed, fertilizer, pesticide, farmer's age, farmer's literacy level, amount of credit, intercept and error term respectively. It can be mentioned that labor, seed, fertilizer and pesticide are physical inputs directly influence output or production. Bank is a dummy variable indicating whether the farmer has formal bank account or not. BN, Bsd, BF and Bp are first derivatives. BNN, BSdSd, BFF and BPP are own second derivatives. BNSd, BNF, BNP, BSdF, BSdp and BFP are cross second derivatives. This study excludes land as a factor of production as output and all other physical inputs are measured with respect to per unit of land. Table 1 presents details of variables mentioned in the translog function of production. Elasticity of output accordance to inputs denotes the responsiveness of change in output due to changes in inputs. We can derive them through differentiating the translog production with respect to each physical factor input.

$$\partial \ln Y / \partial \ln N = e_N = \beta_N + \beta_{NN} \ln N + \beta_{NSd} \ln Sd + \beta_{NF} \ln F + \beta_{NP} \ln P \quad \ldots (2)$$

$$\partial \ln Y / \partial \ln Sd = e_{sd} = \beta_{sd} + \beta_{Nsd} \ln N + \beta_{sdSd} \ln Sd + \beta_{sdF} \ln F + \beta_{sdP} \ln P \quad \ldots (3)$$

$$\partial \ln Y / \partial \ln F = e_F = \beta_F + \beta_{NF} \ln N + \beta_{SdF} \ln Sd + \beta_{FF} \ln F + \beta_{FP} \ln P \quad \ldots (4)$$

$$\partial \ln Y / \partial \ln P = e_P = \beta_P + \beta_{NP} \ln N + \beta_{SdP} \ln Sd + \beta_{FP} \ln F + \beta_{PP} \ln P \quad \ldots (5)$$

To estimate output elasticity average value of InN, InSd, InF and InP are taken. From above mentioned equations, eN, esd, eF and ep represent output elasticity of labor, seed, fertilizer and pesticide respectively. Marginal productivity of each input is determined as follows.

$$MP_N = e_N \cdot (\overline{Y}/\overline{N}) \quad \ldots (6)$$

$$MP_{Sd} = e_{sd} \cdot (\overline{Y}/\overline{Sd}) \quad \ldots (7)$$

$$MP_F = e_F \cdot (\overline{Y}/\overline{F}) \quad \ldots (8)$$

$$MP_P = e_P \cdot (\overline{Y}/\overline{P}) \quad \ldots (9)$$

Where MPN, MPsd, MPF and MPP notifies marginal productivity of labor, seed, fertilizer and pesticide and $\bar{Y}$, $\bar{N}$, $\bar{S}d$, $\bar{F}$ and $\bar{P}$ indicate average value of output, labor, seed, fertilizer and pesticide.[26]

3.3.2 Analysis of Principal Component

The Analysis of Principal Component (APC) indicates a multivariate statistical method which is used for reducing the variable number in a data set into a lower number of dimensions.[33,34] It is extensively used by researchers of behavioral science to evaluate the dimensional structure of data[35]. Farmers have different perception about financial inclusion. This study also uses PCA for indexing variables on farmers' perception on different aspects of financial inclusion like challenges in accessing loan from banks and repaying them, government's conception and involvement to address these challenges, and outcomes from raised access to finance in agriculture.

These variables are measured through categorical or psychological scale. Mathematical conceptualization of PCA for this study is based on Manly[33]; Vyas and Kumaranayake.[34] Mathematically, from a primary set of n correlated variables, PCA generates uncorrelated components or indices and all component is derived from linear weighted combination of previous variables. Let, a set of variables or factors X from X_1 to X_n.

$$PC_1 = a_{11}X_1 + a_{12}X_2 + \cdots + a_{1n}X_n \quad \ldots(10)$$

$$PC_m = a_{m1}X_1 + a_{m2}X_2 + \cdots + a_{mn}X_n \quad \ldots(11)$$

Where, a_{mn} denotes the weight for the mth principal component and the nth variable. The eigenvectors of correlation matrix or the co-variance matrix gives weights for every principal component. The Eigen value of the respective Eigen vector also gives the variance (λ) for all principal component. The components are arranged sequentially and the maximum possible variation in the original data is explained by the first principal component (PCI), subject the sum of the squared weights ($a_{11}^2 + a_{12}^2 + \ldots\ldots\ldots\ldots + a_{1n}^2$) equals one.

Since the sum of the eigenvalues is equal to the number of variables in the initial data set, the proportion of the total variation in the original data set accounted by every principal component is λ_i/n. All subsequent components are uncorrelated with previous components and each of them captures additional variation in the data less than PCI. Factors on farmer's perception analyzed through PCA are mentioned in Table 6. This study analyzes factors or variables through PCA excluding a variable namely government's concern and the involvement in addressing challenges in financial inclusion in agricultural sector as it has only two factors.

4. Results

4.1 Socioeconomic Conditions of the Farmers

This study discusses farmers' socioeconomic conditions through farmers' age, family size, earning members, literacy level, monthly agricultural income, monthly non-agricultural income, monthly consumption expenditure, cultivable land, land used in rice production, rice produced, labor, seed, fertilizer, and pesticide. Some other variables regarding credit, such as the amount of credit, the number of installments, payment per

installment, and interest rate, are also discussed in this study. Table 2 illustrates these socioeconomic issues briefly.

TABLE 2: Descriptive Statistics.

Variables	Unit measurement	Obs.	Mean	Std. Deviation	Min.	Max.
Age	Year	100	44.79	8.51	28	62
Family members	Number	100	4.31	1.02	2	6
Earning members	Number	100	1.2	0.49	1	4
Literacy level	Year of schooling	100	7.87	2.27	4	16
Monthly Agricultural Income	BDT	100	4430	2057.28	2000	15000
Monthly non-agricultural Income	BDT	100	6560	6524.34	0	50000
Monthly Consumption Expenditure	BDT	100	9336.8	5055.87	3970	38700
Cultivable land	Bigha	100	4.365	2.41	2	20
Land used in rice production	Bigha	100	3.955	1.69	1	20
Rice produced	Maund per bigha	100	21.477	6.86	10	40
Labor	Man days per bigha	100	22.921	7.76	2.5	40
Seed	Kg per bigha	100	5.451	1.15	2.5	11.43
Fertilizer	Kg per bigha	100	38.689	7.118	4.167	50
Pesticide	Kg per bigha	100	0.698	1.01	0.017	4
Amount of credit	BDT	40	46875	16705.88	25000	80000
Number of installment	Number	40	2.93	1.23	1	6
Payment per installment	BDT	40	20735.08	10544.62	5550	61,600
Interest rate	Percentage	40	12.475	0.99	11	14

Source: Authors' Estimation Based on Field Survey, 2025

The mean age of a farmer is 45 years of the respondents. Most of the farmers have 4 family members 1of them is an earning member on average. Minimum, maximum, and average years of schooling are 4, 16, and 7.87 years, respectively. Most of the farmers have two sources of income: agriculture and other sectors. Minimum monthly non-

agricultural income is zero since some farmers have no other source of income except agriculture. The average cultivable land of a farmer is 4.365 bigha, of which 3.955 bigha is used in rice production. The amount of rice production varies due to land fertility and farmers' expertise in using other inputs directly related to production, which may be affected by financial constraints. In this study, 59% of farmers have a formal bank account, and only 40% of farmers have taken credit from a bank for agricultural purposes. Interest rate differs based on the amount of credit, repayment period, and other banking policies.

4.2 General Perception of Farmers about Financial Inclusion

Farmers have different perceptions regarding financial inclusion. Their perceptions are categorized into the following categories: challenges in accessing credit from banks, challenges in repaying credit, the concern and involvement of government in addressing these obstacles, and outcomes from increasing access to finance in agriculture. The study summarizes these issues, which are presented in Table 3.Among all farmers under consideration, 37% strongly agree that the unwillingness of banks to give credit to the agriculture is one of the major challenges of accessing loans from banks. Mostly banks are situated in urban and suburban areas, and 53% of farmers agree that it is quite difficult to get access in institution due to the long distance from their residences. A large number of farmers, i.e., 57%, agree that the repayment period of loan is short relative to harvest. Because it takes a moderate time to get a harvest. Besides, 69% agree that they fail to generate sufficient revenue to repay the loan. Moreover, 22% farmers strongly agree that, they have wrong notion about loan and it impedes to repay loan at times. According to table 6, 48% farmers agree that if financing increases agricultural production also increases. Besides, 41% farmers agree that it also helps to acquire inputs for production. It reduces poverty which is agreed by 46% farmers. As well, 50% farmers strongly agree that their income increases as production increases.

TABLE 3: Correlation Among the Variables.

	Y	N	Sd	F	P	Ag	Lt	Bank	Credit
Y	1.000	-	-	-	-	-	-	-	-
N	0.625*	1.000	-	-	-	-	-	-	-
Sd	-0.101	0.009	1.000	-	-	-	-	-	-
F	0.459*	0.349*	-0.108	1.000	-	-	-	-	-
P	0.686*	0.525*	0.035	0.388*	1.000	-	-	-	-
Ag	-0.069	0.128	-0.101	0.041	0.056	1.000	-	-	-
Lt	0.103	0.023	0.065	0.281*	0.157	-0.013	1.000	-	-
Bank	0.311*	0.104	0.098	0.221*	0.377*	-0.215*	0.186	1.000	-
Credit	-0.143	-0.080	0.091	-0.228	-0.117	-0.140	0.109	0.488*	1.000

N.B: * p<0.01, ** p<0.05, *** p<0.1 (Source: Authors' Estimation Based on Field Survey, 2025)

4.3 Estimation of Production Function

This study estimated a trans-log production function through regression analysis. It reveals at what extent the change of the variable inputs affects production or output. Table 4 summarizes the results of estimating production function.

TABLE 4: Estimation of Production Function.

Variables	Coefficients	Standard Errors	t statistic
InN (Labor)	-1.824*	0.964	-1.892
InSd (Seed)	2.785	2.013	1.383
InF (Fertilizer)	0.0201	0.877	0.023
InP (Pesticide)	0.476	0.583	0.816
In Ag (Age)	-3.729	3.854	-0.967
InLt (literacy level)	0.403	0.862	0.467
$(InN)^2$	0.582*	0.348	1.672
InN.InSd	-0.0818	0.389	-0.210
InN.InF	0.0965	0.185	0.521
InN.InP	-0.195*	0.108	-1.805
$(InSd)^2$	-1.442*	0.844	-1.708
InSd.InF	0.0288	0.215	0.134
InSd.InP	0.0792	0.171	0.463
$(InF)^2$	-0.0630	0.0917	-0.687
InF.InP	0.04	0.0674	0.593
$(InP)^2$	0.143**	0.0633	2.259
$(InAg)^2$	0.936	1.024	0.914
$(InLt)^2$	-0.217	0.423	-0.513
Bank	-0.0205	0.0595	-0.344
InCrdt	0.0104*	0.00626	1.661
Constant	9.781	8.038	1.217
Observations	100		
R-squared	0.679		

Note: * p<0.01, ** p<0.05, *** p<0.1 (Source: Authors' Own Calculation Based on Field Survey, 2025)

The estimated coefficients from the production function provide important insights into the contribution of key inputs to agricultural output. The coefficient of labor indicates that a 1% increase in labor use leads to an increase in agricultural output, suggesting that labor remains a vital input in the production process. Similarly, the coefficient of seed is positive, implying that improved or increased seed usage enhances productivity. This finding highlights the importance of quality seed adoption in boosting agricultural performance. Fertilizer use also shows a positive relationship with output, indicating that increased application contributes to higher yields. This result is consistent with

agricultural production theory, where fertilizer plays a crucial role in improving soil fertility and crop growth. Furthermore, access to credit exhibits a positive association with agricultural output. This suggests that farmers with better access to financial resources are able to invest more effectively in inputs and technologies, thereby improving productivity.

To assess multicollinearity among the explanatory variables, the Variance Inflation Factor (VIF) was computed following the regression estimation. The mean VIF is 6.14 which indicate that multicollinearity is within an acceptable range and does not pose a serious concern for the reliability of the estimated coefficients. Furthermore, the suitability of the data for Principal Component Analysis (PCA) was evaluated using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. The KMO value is 0.71 which suggests adequate sampling adequacy. In addition, Bartlett's Test is statistically significant ($\chi^2 = 245.32$, $p < 0.001$), confirming that the variables are sufficiently correlated to justify the application of PCA.

4.4 Elasticity of Output and Marginal Productivity of Variable Inputs

Output elasticity of different inputs shows the percentage of change in output caused by percentage change in those inputs. Whereas, marginal productivity of an input refers the additional output due to 1 unit change in input. Table 5 narrates the elasticity of output and marginal product of each input factor.

TABLE 5: Elasticity of Output and Marginal Productivity of Variable Inputs.

Input	Output Elasticity (e)	Marginal Product (MP)
Labor (N)	0.352	0.330
Seed (Sd)	0.118	0.464
Fertilizer (F)	0.117	0.065
Pesticide (P)	-0.022	-0.684

Source: Authors' Estimation Based on Field Survey, 2025

The output elasticities are calculated using the translog production function, which indicates how production changes when one of the inputs changes. The findings indicate that labor, seed, and fertilizer have positive elasticities, implying that they all contribute to increased agricultural output. Pesticide, on the other hand, has negative elasticity, which could indicate that it is being applied excessively or improperly. However, not all of the computed coefficients show statistical significance. As a result, the associated elasticities must be read with caution, and firm conclusions about their magnitude should be avoided.

4.5 Analyzing Farmer's Perception through Principal Component Analysis

This research employs principal component analysis (PCA) to construct indices of farmers' perception on financial inclusion. PCA gives weights to the variables based on their variability; more the variability, more the weights. Table 6, 7 and 8 displays the

results of PCA of variables segmented into 3 main variables; challenges in accessing loan, challenges in repayment and output of increased financing in agriculture. This study considers that, the first principal components can measure the main variables as the component has highest eigenvalue which is greater than 1. These eigenvalues of all components and the KMO test is required to satisfy the conditions for PCA. Factor score or scoring factor of each variable is associated with previously mentioned main variables of financial inclusion. A variable that has positive factor score shows higher association with broad variable and vice-versa. In this sense, inadequacy of collateral to backup loan is highly associated with challenges in accessing loans (CAL) from banks and this variable is ranked higher in terms of CAL. Inability of financial institutions access in rural locations has negative factor score which means this variable is ranked lower in terms of CAL. Wrong notion of farmers regarding loan is ranked higher in terms of CRL. Reduction in poverty level shows highest association with results of increased financial access (RIAF) in the agricultural sector. Factor of difference (DF) is obtained from scoring factor divided by standard deviation. Increase or decrease of perception in categorical scale (from 1 to 5) from one respondent to next about a variable is influenced by DF of that variable. Second variable (loan processing is time consuming) of CAL has positive DF which denotes that a farmer's perception is higher than that of previous farmer regarding this variable and it is influenced by the DF. Second variable of RIAF has negative DF and it influences a farmer's perception to lower than that of previous farmer regarding this variable. The extracted principal components explain a substantial proportion of the total variation in farmers' perceptions, indicating the adequacy of the selected variables in representing the underlying dimensions of financial inclusion. Therefore, the PCA-based indices serve as reliable measures for analyzing the relationship between financial inclusion and agricultural development.

Table 6: Results of Principal Component Analysis: Challenges in Accessing Loan.

Description of Variables	Scoring Factor	Mean	Std. Dev.	DF
High and unaffordable interest rate	0.3109	3.5	0.9482	0.3279
Loan processing is time consuming	0.5761	4.2	0.6963	0.8273
Cost of loan processing is high	0.1350	4.02	0.9845	0.1371
Inadequacy of collateral to backup loan	0.6038	3.78	0.7730	0.7810
Unwillingness of banks to give credit to agriculture sector	0.0074	4.25	0.6571	0.112
Inability to access banks in remote locations	-0.4343	4.09	0.6830	-0.6358

Source: Authors' Estimation Based on Field Survey, 2025

This study attempts to examine whether increased access to financial services can bring about change in agricultural output. Approaching through statistical and mathematical

tool researcher comes to some ending points as follows. Respondents' monthly agricultural income is less than monthly non-agricultural income. Farmer's average cultivable land is 4.365 bigha and average land used in rice production is 3.955 bigha, their average rice production is 21.47 maunds per bigha in a season. In accordance with the study, among 59 percent farmers have formal bank account and only 40 percent farmers have taken credit from bank for agricultural purpose. Correlation demonstrates that, labor, fertilizer and pesticide, having a bank account and credit facility have significant association on agricultural output

TABLE 7: Challenges of Repaying Loans (CRL) to Bank.

Description of Variables	Scoring Factor	Mean	Std. Dev.	DF
Short repayment period relative to when stocks start yield	0.4887	4.18	0.7018	0.6964
Refusal by banks to extend repayment period	0.4381	4.01	0.8586	0.5102
Stock losses to death, disease or theft cause financial setback	0.3557	4.14	0.7524	0.4728
Funds diversion by farmers to other non-productive use	0.1062	4.01	0.7453	0.1425
Inability to generate sufficient revenue to repay loan	0.3442	4.05	0.6093	0.5649
Notion by farmer that loan is a grant, which is not repayable	0.5595	3.84	0.8844	0.6326

Source: Authors' Estimation Based on Field Survey, 2025

TABLE 8: Results of Increased Access to Finance (RIAF) in the Agricultural Sector.

Description of Variables	Scoring Factor	Mean	Std. Dev.	DF
Increase in output as a result of increase in financing	0.5024	4.34	0.6391	0.7861
Increase in acquisition of resource inputs	-0.0502	4.02	1.0729	-0.0468
Reduction in poverty level	0.5039	4.25	0.7160	0.7038
Farmer's income increase due to production increase	0.4882	4.42	0.6385	0.7646
Large scale production reduces average cost	0.1947	4.32	0.7898	0.2465
Acquisition and use of modernized farming techniques	0.0108	3.83	1.0353	0.0104
Generation of sufficient revenue to repay loan	0.4634	4.26	0.7470	0.6204

Note: DF means difference factor= Scoring factor / Standard deviation
Source: Authors' Estimation Based on Field Survey, 2025

Regression analysis reveals a significant, non-monotonic link between labor and production. Seed and pesticides have negative and positive monotonic associations with productivity. Age, literacy, and fertilizer do not always correlate with productivity in a straight line. Using additional labor and insecticides together reduces agricultural productivity. Agricultural financing has a significant positive effect on output. It clearly shows that a 1% increase in a farmer's bank credit enhances agricultural output by 0.0104 percent. The output elasticity of labor exceeds that of other inputs. Using too many pesticides reduces production. Fertilizer is the most variable physical input used in farming, with the highest marginal productivity. Most farmers believe that the government is worried about the problems with agricultural funding but isn't doing anything to fix them. Principal component analysis shows that the main problem in getting a loan from a bank is not having enough collateral to back it up. Some farmers believe that a loan is a gift that does not need to be paid back. It is the hardest thing to do when it comes to paying back a debt. The best results of increased financial access in the agriculture industry include a lower poverty rate and higher production levels.

5. Discussion

The regression results indicate that access to formal credit has a positive and statistically significant association with agricultural output, while simple ownership of a bank account does not show a significant positive relationship. This distinction is important. It suggests that financial inclusion in its functional form (i.e., access to credit) matters more than mere financial access (account ownership). This finding aligns with the theoretical argument of studies which emphasizes that credit constraints limit farmers' ability to adopt productivity-enhancing inputs.[36] Similarly, empirical studies demonstrate that access to rural credit significantly improves farm productivity and household welfare in Bangladesh.[37] However, the negative or insignificant coefficient of the "Bank" variable reflects a structural issue: financial inclusion without effective utilization does not translate into productivity gains. The discrepancy between the positive correlation and the negative regression coefficient may be explained by multicollinearity among the explanatory variables or the presence of omitted variable bias. Unlike simple correlation, the regression model accounts for the joint influence of multiple covariates, which can lead to changes in both the sign and magnitude of the estimated relationship. This is consistent with broader development literature, which argues that usage—not just access—is the key dimension of financial inclusion.[38]

The elasticity results show that labor has the highest output elasticity, followed by seed and fertilizer, while pesticide exhibits a negative elasticity. This indicates that labor remains the dominant factor in smallholder agriculture, which is consistent with labor-intensive farming systems in Bangladesh. The negative elasticity of pesticide suggests inefficient or excessive application, which may reduce productivity. This result is supported by findings from Food and Agriculture Organization, which highlight that misuse of agrochemicals can harm soil quality and reduce crop yield over time.[39] It may also reflect lack of technical knowledge, reinforcing the role of extension services and farmer education. Furthermore, the relatively low elasticity of fertilizer, despite positive

marginal productivity, suggests diminishing returns or suboptimal input combinations, consistent with production theory. This supports the argument of Schultz, who emphasized that improving farmer knowledge and resource allocation efficiency is critical for productivity growth.[40]

The translog estimation reveals non-monotonic relationships between several inputs (labor, fertilizer, age, literacy) and output, indicating complex input interactions and diminishing returns. The significant interaction between labor and pesticide suggests that joint overuse may reduce efficiency, possibly due to mismanagement or improper timing of application. Such non-linearities are consistent with flexible functional forms like the Translog Production Function, which allow for substitution and complementarity among inputs. However, the instability of some coefficients also reflects data limitations and potential multicollinearity, as noted by the reviewer.

The PCA results provide a behavioral dimension to the analysis. Farmers identify collateral requirements, lengthy loan processing, and limited rural access to banks as major barriers to financial inclusion. These findings strongly align with the rural finance literature in developing countries. For example, Abhijit Banerjee and Esther Duflo argue that institutional barriers, rather than lack of demand, often constrain financial access among the poor[41]. Similarly, the perception that loans are sometimes viewed as grants indicates financial literacy gaps, which can undermine repayment behavior and sustainability of credit programs. These perceptions are consistent with empirical evidence from International Food Policy Research Institute, which shows that credit access enhances input use, productivity, and rural welfare.[42]

The PCA results give more information on how farmers feel about financial inclusion. Farmers who are more conscious of their finances, as shown by the PCA index, are more likely to use and access formal financial services. This behavioral aspect corresponds with the regression results, which demonstrate a favorable correlation between financial inclusion and agricultural productivity. So, the results as a whole show that both access to financial services and farmers' awareness are critical factors that affect how well agriculture does.

6. Conclusion

Agriculture holds a crucial position in the economy of Bangladesh, as it offers means of survival for a considerable segment of the populace. Nevertheless, the sector encounters obstacles related to the availability of financial assets and services. In this research, we have tried to explore the relation between increased access to financial services and its association on agricultural output. Our findings reveal that having a formal bank account and agricultural credit access significantly influence agricultural output, as evidenced by correlations and regression analyses. Notably, a 1 percent increase in agricultural credit from banks is associated with a 0.0104 percent increase in agricultural output. Furthermore, our research highlights uncovered farmers' perceptions regarding government involvement in agricultural financing, with many believing that more could be done to address these challenges. Principal component analysis identified the

inadequacy of collateral as a major barrier to accessing loans, and the misconception of loans as grants as a significant challenge in repayment.

To address these challenges, we propose a multifaceted approach. Firstly, the expansion of banking services in remote areas is essential to make financial resources more accessible to farmers. Secondly, government oversight in agricultural financing activities should be strengthened to ensure fair lending practices. Thirdly, education and awareness campaigns should be initiated to enlighten farmers about responsible financial management. Additionally, innovative collateral solutions and targeted support programs can further empower farmers to harness the benefits of financial inclusion. By adopting these strategies, we aim to foster greater financial accessibility and ultimately elevate agricultural productivity, resulting in a brighter economic future for Bangladesh. The findings of this research are based on a specific region within Bangladesh, and the results may not be fully representative of the diverse agricultural landscapes and economic conditions across the entire country. Agricultural practices, financial infrastructure, and Socio-economic factors can vary significantly between regions, which may limit the generalization ability of our conclusions. The limitations of this research open avenues for future studies to delve deeper into specific aspects of the inclusion of finance in agriculture, like the association of digital financial services, the role of local cooperatives, or the relationships of government support programs.

However, this study has significant drawbacks. The use of cross-sectional data limits the capacity to make causal inferences, thus the findings should be taken as associations. Furthermore, the partial use of purposive sampling may introduce selection bias and reduce the generalizability of the findings. Finally, potential endogeneity and omitted variable bias cannot be completely eliminated. Future study with panel data and more stringent identification procedures is encouraged.

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Conflicts of Interest
The authors have no conflict of interest.

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