

## Measuring the Effectiveness of Agricultural Credit in Increasing Farm Productivity: An Empirical Analysis

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**[Abstract]** The present study investigates how institutional credit affects agricultural productivity. Primary data was collected through field surveys using a random sample method. A well-designed survey questionnaire facilitated data collection through interviews with chosen informants and direct inquiries to the target population. The collected data was analyzed using the Logistic Regression Model. The results show a positive impact of credit on agricultural productivity. Additionally, factors such as family size, income, education level of farmers, and availability of agricultural finance significantly influence agricultural production per acre in a positive manner. These findings suggest that providing farmers with appropriate and timely loans can improve agricultural output, thereby enhancing productivity. Access to loans enables farmers to procure high-quality seeds, efficient fertilizers, weedicides & pesticides, and utilize advanced mechanized agricultural systems, leading to timely and adequate input supply and subsequent increase in agricultural yield.

**[Keywords]** agricultural credit, farm productivity, logit model, policy implications

### Introduction

Agriculture serves as the backbone of rural economies, and access to agricultural credit is crucial for modernization, fostering growth and development (Chandio et al., 2018; Mendola & Tasciotti, 2018; Agbodji & Johnson, 2021). Many nations worldwide rely on extensive government intervention in credit markets to overcome market failures and prevent widespread usurious informal lending, which can hinder agricultural development and productivity (Abdallah, 2016; Kabir et al., 2020; Chen and Lu, 2021; Yadav and Rao, 2022). Despite being a long-standing characteristic, there hasn't been much study on whether these government interventions actually help farmers overcome credit restrictions and assist agricultural productivity and growth (Narayana, 2016).

India is often described as an "agrarian nation" due to agriculture's importance, accounting for almost 50% of the country's economy (Ministry of Agriculture and Farmers Welfare, 2022). According to the 2020-2021 economic survey, the contribution of the agriculture sector to GDP has exceeded 20% for the first time in the last two decades (The Economic Survey- 2020-2021-Ministry of Finance, 2021; Manoharan & Varkey, 2022). In recent years, India's economy has made substantial progress overall, and capital-intensive changes have occurred in the agricultural sector (Ministry of Statistics and Programme Implementation, 2022; Ministry of Agriculture & Farmers Welfare, 2022). However, the industry continues to suffer from various underlying and apparent issues, including natural and man-made causes such as physical issues, lack of irrigation facilities, inadequate finance, insufficient marketing strategies, and ineffective cooperative structures (Hussain & Taqi, 2014; Abdallah, 2016; Yadav & Rao, 2022). Thus, it is evident that agricultural production holds significant importance.

Agricultural credit plays a crucial role in enabling farmers to utilize resources and inputs effectively, adopt modern technologies, and allocate resources appropriately, all of which enhance productivity (Agbodji & Johnson, 2021; Xu et al., 2021; Kumar et al., 2023). However, many small-scale farmers lack the financial resources to run their farms using contemporary agricultural practices. Availability of sophisticated infrastructure, high-yielding seed varieties, quality fertilizers, pesticides, water

for irrigation, mechanization, and land restoration are essential for enhanced agricultural productivity and growth (Hussain & Taqi, 2014; Abdallah, 2016; Charyulu, 2018).

The increased demand for loans in the agricultural sector can be attributed to price increases over the past three decades in crucial areas, including fertilizer, herbicides, high-yield variety seeds, automation, and labor. Additionally, agricultural financing is crucial for economic development driven by agriculture, especially when extending finance to small-scale farmers (Anetor et al., 2016; Abdallah, 2016; Kabir et al., 2020; Mendola & Tasciotti, 2018; Kumar et al., 2021; Manoharan & Varkey, 2022; Mbukwa & Lwesya, 2023).

In India, borrowers can choose between informal and formal sources of credit. Informal credit can be obtained from various sources, including friends and family, dealers, and private money lenders, while formal sources include banks, non-banking financial institutes, government departments, and cooperative groups. Banks play a significant role in agricultural financing, accounting for a major share of institutional and agricultural loans in the country. They have pioneered agriculture's mechanization by offering easy terms and conditions on loans for tractors and tube wells, which have increased farm productivity and cropping areas.

Government schemes like the Kisan Credit Card scheme, active nationwide since 1998, make affordable agriculture finance more accessible to small farmers, serving as a lifeline for financially strapped farmers. However, farmers in rural areas are often hesitant to apply for credit from formal institutions due to several reasons, including high-interest rates, long distances to banks, lengthy application processes, unreasonable payment wait times, unlawful demands made by officials, disagreements between bank revenue departments, and the need for collateral. These challenges pose significant hurdles in India's existing credit system and deter farmers from accessing formal credit sources (Manoharan & Varkey, 2022).

Existing research indicates that relaxed agricultural credit constraints significantly enhance productivity among small-scale farmers, enabling them to adopt improved farming practices (Chen & Lu, 2021; Xu et al., 2021). Therefore, the shortage and unequal access to agricultural credit represent significant obstacles to the growth of the rural agricultural economy. Considering this discussion, the current study aims to assess how agricultural financing affects output and productivity. To achieve this goal, it seeks to estimate farmers' borrowing habits using a Logit regression model (Mbukwa & Lwesya, 2023).

### Review of Literature

Access to timely and adequate agricultural credit assists farmers in funding agricultural activities while also protecting them from potential productivity-reducing risks and uncertainties (Agbodji & Johnson, 2021). However, constraints in the credit market and inadequate insurance can limit investments in highly profitable agricultural activities (Karlán et al., 2014; Agbodji & Johnson, 2021). Researchers have shown that credit availability positively impacts agricultural production yield per acre after adjusting for the farmer's education and family size (Hussain & Taqi, 2014; Abdallah, 2016). Previous studies have attempted to justify how agricultural financing increases output. For example, credit availability has accelerated the use of irrigation facilities, mechanized farming, and the application of fertilizer and pesticides. According to various researchers (e.g., Hussain & Taqi, 2014; Akudugu, 2016), credit makes it possible for farmers to buy superior varieties of seeds, more potent pesticides, and fertilizers, which boosts agricultural output in an opportune manner.

According to Siebel (2000), farming is a seasonal occupation. Agricultural credit institutions, therefore, need to increase their lending supply during planting time. The study highlighted the need for agricultural finance institutions to provide loans specifically for farming operations, particularly crop cultivation. Iqbal et al. (2003) promoted the supply of agricultural loans by formal financial institutions, especially for small landholders. The results of their research indicate that impoverished farmers have access to consumption loans from their respective organizations in times of natural disasters like floods or drought.

Crop insurance and other protective plans are essential to reduce the risks associated with insect assaults, drought, and heavy rains. Farmers can pay a small premium for these plans, further protecting their interests. Fayaz (2006) found that bank loan programs are the most effective tool for agricultural expansion since they significantly impact farmers' output and income.

Researchers have claimed that access to finance is critical to the development process, allowing farmers to invest in new machinery and other productivity-boosting technologies, thereby increasing agricultural output. Additionally, the study claimed that the short-term nature of informal loans does not support sustained productivity, and there is a detrimental effect on rural development and quality of life when poor rural people cannot access institutional loans. Waheed (2009) provided evidence that microfinance is crucial in lifting the rural poor out of poverty, especially concerning investments in rural productive enterprises. The research found that providing loans to farmers who are not impoverished had a greater impact than giving credit to poor farmers. Furthermore, the study highlighted that microcredit usage is disproportionately high among prosperous farmers, making it difficult for poor farmers to access the money they need.

Akhtar et al. (2020) asserted that increased access to agricultural financing increases crop yields. The study results indicated that expanding farmers' access to credit might boost agricultural output and farm production. Similar results were obtained in research investigations carried out in Nigeria by Awotide et al. (2020) and Bangladesh by Khan et al. (2021), respectively, where agricultural financing helped increase farmers' harvests and overall agricultural productivity. These results indicate that expanding opportunities to get farm loans can boost output. Gupta and Singh (2021) also found that access to agricultural loans positively affected crop yield in the state. These results indicate that expanding farmers' access to agricultural loans may boost output on Uttar Pradesh's farms.

In Kenya, Nyasimi et al. (2020) instituted that conservation agricultural approaches boost harvest yields. The results emphasize the value of using cutting-edge agricultural methods and tools to increase farm output. Pandey and Chandel (2021) discovered that agriculture production rose sharply once farmers began using modern agricultural techniques. The results emphasized the value of implementing cutting-edge agricultural methods. Bhat et al. (2021) established that increasing access to agricultural financing led to higher statewide crop yields. Modern agricultural technology, such as drip irrigation and automation, were also found to boost farm output (Singh et al., 2023). Similarly, Singh et al. (2021) found that implementing cutting-edge farming techniques increases agricultural productivity. According to a study by Wang et al. (2022), using precision agriculture technology and having access to agricultural loans led to significant gains in crop yields in China. These results stress the need for increased farm production through the implementation of contemporary agricultural technology and practices.

Kumar et al. (2020) showed that the credit or subsidy obtained from the government for agricultural inputs resulted in increased crop yields. The results, in general, pointed to the importance of government measures in boosting agricultural finance and farm output. Numerous research has been conducted globally to comprehend how agricultural finance and agricultural productivity are related. However, there is no conclusive consensus. In essence, there is a commonly held assumption in the research community that more credit and timely availability can also be connected to higher levels of productivity and growth. However, there is no solid empirical data to back up this claim. Hence, the present study attempts to fill this gap and answer the question diligently.

### Study Area

Agriculture provides around 59% of employment to the residents of Uttar Pradesh state in India (Ministry of Agriculture and Farmers Welfare, 2022; Manoharan & Varkey, 2022). According to available data, Uttar Pradesh stands as the preeminent milk-producing state in the nation. In the fiscal year of 2020, Uttar Pradesh had the honour of securing the highest percentage of milk production in India, amounting to approximately 16%. Uttar Pradesh's climate is so diverse that almost every kind of crop is produced here, including Rabi, Kharif, and Zayed crops. This diversity contributes to Uttar Pradesh's leading position in the production of many crops grown in the country. The present study primarily aims to evaluate the influence of agricultural

credit on productivity and yield in five districts of Uttar Pradesh, namely Fatehpur, Kanpur Nagar, Kanpur Dehat, Raebareli, and Unnao.

### Hypotheses Development

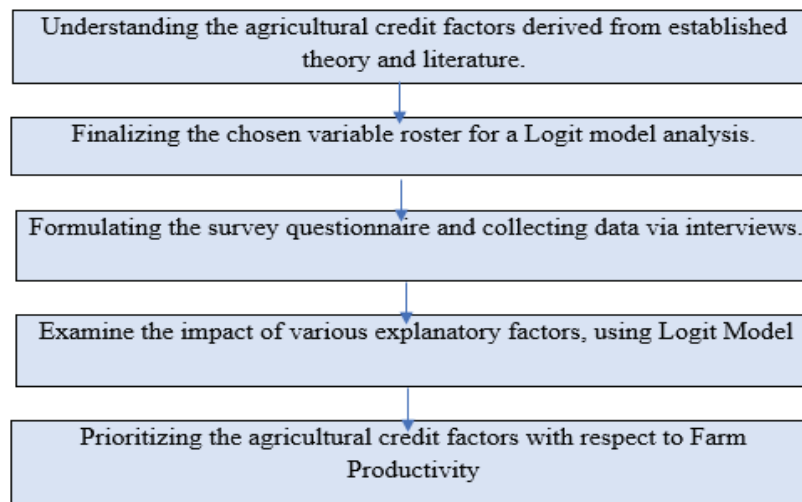
Based on extensive literature analysis and expert opinions, the present study considered several significant variables. The study hypotheses, grounded in both theoretical and empirical evidence, are as follows: The amount of Credit (CRT), Family Income (FI), Family Size (FS), Farmer Education Level (EL), Farmer's Age (AG), Short-Term Loans (SL), Long-Term Loans (LL), Past Borrowing Frequency from Banks (PBF), and Livestock Holdings (LSH) all positively impact agricultural productivity.

### Research Methodology

The current study utilized a logistic regression model to analyze the data gathered through a primary survey. A random sample method was employed to conduct the survey, with 300 farmers selected representing 10 villages in each district. Data collection involved interviews with selected informants and direct inquiries to the target population. The survey questionnaire comprehensively covered various socio-economic attributes related to the agriculturalists. The stepwise research methodology is detailed in Figure 1 below.

**Figure 1**

*Step-Wise Research Methodology*



The current investigation has considered several significant quantitative explanatory factors taking into consideration the established theories and pertinent literature. The variables selected for the Logit model analysis are enlisted in the Table 1 below.

**Table 1***List and Description of Selected Variables for Logit Model Analysis*

Variable	Variable description
<b>Dependent Variable</b>	
AP	Outcome of credit borrowing on agricultural productivity = 0 No productivity enhancement = 1 Productivity enhancement
<b>Independent Variable(s)</b>	
CRT	Credit Amount Borrowed (Annually)
FI	Family Income
FS	Family Size
EL	Farmer Education Level = 0 Farmer uneducated/illiterate = 1 Farmer educated/literate
AG	Farmer's Age (in years)
SL	Short term loan = 0 No short-term borrowing = 1 Short term borrowing
LL	Long term loan = 0 No long-term borrowing = 1 Long term borrowing
PBF	Number of times loan borrowed in past from the bank(s)
LSH	Livestock holdings = 0 No livestock holdings = 1 Livestock holdings

Given the methodological concerns and operational issues, the primary focus is on increasing agricultural output (AP). Input-output ratios are crucial in calculating agricultural yield or productivity. While most goods are measured by mass, calculating agricultural production as a whole is complicated by variations in product densities. Therefore, the market value of the completed product is typically used in the assessment of output. A Probit or Logit Model is typically employed to utilize regressions. An increase in agricultural output due to using credit for inputs is represented by a dummy or categorical variable in the Probit or Logit model. Next, a regression analysis is conducted using this binary variable and the explanatory factors of choice. The Logit Model is then used to examine the impact of various explanatory factors, such as access to agricultural loans, on agricultural output.

In terms of methods used, the rationale for employing the Logit model is worth considering. An endogenous variable is used as a dummy in the Logit Regression Model. Specifically, the variable takes on the value of one when productivity increases and zero otherwise. The probability of an increase in productivity depends on various factors.

Using a set of variables  $Y$ , this is denoted by the following equations:

$$\begin{aligned} \text{Probability } (X = 0) &= 1 - F(\beta'Y) \text{ and} \\ \text{Probability } (X = 1) &= F(\beta'Y) \end{aligned}$$

Then, the probability of  $X = 1$  is determined using the logistic distribution and expressed as:

$$\text{Probability } (X = 1) = e^{(\beta'Y)} / (1 + e^{(\beta'Y)})$$

which can be further represented as  $\Lambda(\beta'Y)$ , where ' $\Lambda$ ' denotes the logistic cumulative distribution function.

Considering this scenario, the probability model can be expressed as:

$$E(X/Y) = 0 [1 - F(\beta'Y)] + 1 [F(\beta'Y)], \text{ which ultimately simplifies to } F(\beta'Y).$$

**Results and Discussion**

The present study utilized a Logit regression model to determine the effect of credit borrowing on agricultural productivity (AP). AP is modelled as a dummy variable, with 0 indicating no rise or improvement in AP and 1 indicating a rise in AP due to easier access to credit. Subsequently, the study examined and analyzed the estimates generated by the Logit regression model. The method employed for this analysis was Maximum Likelihood (ML) Binary Logit. Table 2 below presents the estimations obtained from the Logit regression model, illustrating the coefficients of numerous factors on productivity, including farmers' education (EL), family size (FS), the quantity of credit they have, and the availability of short-term loans (SL).

**Table 2**

*Estimations of the Logit Model Analysis have been conducted, with the Dependent Variable being AP*

<b>Statistics</b> <b>Variables</b>	<b>C</b>	<b>FI</b>	<b>FS</b>	<b>AG</b>	<b>LL</b>	<b>PBF</b>
<b>Coefficient</b>	-1.02	1.78**	0.15**	-0.01	0.81**	0.04
<b>Standard Error</b>	0.62	8.72	0.05	0.1	0.35	0.07
<b>Z-Statistic</b>	-1.64	2.07	2.06	-1.03	2.24	0.38
<b>Probability</b>	0.08	0.04	0.04	0.31	0.02	0.7
Mean dependent variance	- 0.49		S.D. dependent variance		- 0.50	
S.E. of regression	- 0.48		Akaike info criterion		- 1.35	
Sum squared residual	- 45.55		Schwarz criterion		- 1.45	
Log likelihood	- 129.43		Hannan-Quinn criterion		- 1.39	
Restr. log likelihood	- 138.54		Avg. log likelihood		- 0.65	
LR statistic (5 df)	- 18.23		McFadden R-squared		- 0.16	
Probability (LR stat)	- 0.00					

Note: \* Indicate 1% of significance level, \*\* 5% and \*\*\* 10% significance level

The data presented in Table 2 indicates a significant and positive correlation between agricultural productivity and household size coefficients (HS), household income (HI), and long-term loans. Interestingly, all these variables show statistical significance at the 5% level. However, despite the expected correlation between a farmer's age (AGF) and the recurrence of bank loans (NB), their impact on agricultural productivity is considered insignificant. It is noteworthy that an increase in household size leads to a greater contribution from household members to agricultural activities, thereby resulting in higher agricultural output. Moreover, when a family's disposable income increases, the farmer's capacity to invest in high-quality inputs like seeds, fertilizers, and pesticides also rises, leading to increased productivity. Taking out a long-term loan (LTL) proves beneficial as it enables farmers to invest in farm automation and adopt better production practices, such as purchasing machinery, installing tube wells, and acquiring their own tractors. Table 3 below presents the estimates of the Logit model with AP as the dependent variable, utilizing the ML - Binary Logit method.

**Table 3***Estimates of the Logit Model with AP as the Dependent Variable*

Statistics Variables	C	CRT	FS	EL	SL	LSH
<b>Coefficient</b>	-1.21	1.79***	1.12***	0.56***	0.51***	0.18**
<b>Standard Error</b>	0.55	1.05	0.06	0.31	0.3	0.53
<b>Z-Statistic</b>	-2.29	1.63	1.9	1.65	1.62	0.37
<b>Probability</b>	0.01	0.08	0.07	0.1	0.09	0.7
Mean dependent variance	- 0.49	S.D. dependent variance		- 0.50		
S.E. of regression	- 0.48	Akaike info criterion		- 1.35		
Sum squared residual	- 45.56	Schwarz criterion		- 1.45		
Log likelihood	- 128.87	Hannan-Quinn criterion		- 1.39		
Restr. log likelihood	- 138.54	Avg. log-likelihood		- 0.64		
LR statistic (5 df)	- 19.34	McFadden R-squared		- 0.17		
Probability(LR stat)	- 0.00					

Note: \* Indicate 1% of significance level, \*\* 5% and \*\*\* 10% significance level.

The results demonstrate a significant positive impact on productivity for all variables at a significance level of 10%. However, the variable of livestock holding (LSH) is considered insignificant despite showing the expected sign. The findings suggest that farmers with access to bank loans tend to invest more in high-quality seeds, fertilizers, and pesticides, consequently increasing agricultural output. Additionally, the increase in household size contributes to enhanced agricultural productivity. With a larger household size, there is a greater number of household members participating in agricultural activities, resulting in an expanded labor force and subsequently higher agricultural yields. Moreover, farmers benefit from short-term loans, which they can utilize for crop-growing activities. Furthermore, the level of education among farmers significantly influences their ability to effectively allocate financial and economic resources to their farming activities. Educated farmers have a better understanding of agricultural challenges and can manage them more effectively compared to their illiterate counterparts (Kumar, 2020; Roy et al., 2022).

### Conclusion and Future Recommendations

The availability of formal agricultural financing significantly and positively impacts output levels, playing a crucial role in increasing agricultural productivity. Variables such as household size, household income, farmer education, credit amount, and loan terms, whether short-term or long-term, have a significant influence on agricultural productivity. While variables like farmer's age, borrowing history with the bank, and livestock show expected signals, they have minimal impact on farm production.

The growth of household size correlates with increased agricultural productivity, as more household members engaging in farm activities significantly impact productivity. Short- and long-term loans from banks enable farmers to make essential investments in their farms, including purchasing seeds, fertilizers, fertilizer spreaders, tube wells, tractors, and adopting automated farming techniques. Both small and large-scale farmers benefit from bank loans, allowing them to invest in high-yield variety seeds, fertilizers, insecticides, and other farming necessities.

Educated farmers are better equipped to anticipate problems and efficiently utilize resources due to their increased awareness of the agricultural sector and its related activities. With rising agricultural output, the income of farmers' households also increases, further promoting farming.

The study recommends several policy initiatives:

1. Ensuring timely provision of credit facilities to avoid delays that may hinder farmers from maximizing profits. Institutional policies should be flexible to maximize productivity and promote the welfare of farmers, especially those with lower levels of education.
2. Lowering interest rates for small farmers compared to larger farms, as small farmers often struggle to meet their basic needs.
3. Providing farmers with loans based on their needs and the value of their crops.
4. Simplifying credit application and repayment processes to assist as many farmers as possible.
5. Offering microcredit as part of a comprehensive package including technical support, marketing assistance, and input supply (seed, fertilizer, pesticides, etc.) to improve borrowers' income and enhance repayment terms.
6. Advocating for policies and initiatives in financing farms that prioritize the common good over narrow profit interests.
7. Exercising due diligence to optimize the efficiency of the borrowing process, including minimizing temporal delays, facilitating collateral acceptance, streamlining documentary formalities, and ensuring fair loan distribution.

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