CHAPTER -5

EMPIRICAL ESTIMATION OF THE IMPACT OF AGRICULTURAL FINANCE ON AGRICULTURAL OUTPUT AND INPUT DEMAND

The purpose of this chapter is to empirically estimate the impact of agricultural finance on agricultural output and input demand. It also examines how agricultural inputs such as fertilizers, seeds, power tillers, and tractors relate to commercial bank credit available to the agriculture sector. Next section of this chapter empirically analyzes the following areas:

5.1 Aspects of Agriculture and Institutional Credit

5.2 Effectiveness of Agricultural Credit on Input Consumption

5.3 Impact of Total Direct and Indirect Credit on Agricultural Output

5.4 Evaluating Output Elasticity in Agriculture

5.1 Aspects of Agriculture and Institutional Credit

In developing countries, where agriculture represents an important sector in the economy, a significant policy goal is to increase the production capacity of agriculture through the increase in the productivity of inputs. People in developing countries rely largely on the agricultural sector directly and indirectly for their livelihood, particularly in rural parts of the country. Therefore, growing agricultural output contributes significantly to both economic growth and poverty reduction. An important factor in overcoming uncertainty and increasing productivity in the agricultural sector is access to credit. Bank lending has become a major part of rural development because it combines both technology innovations and the alteration of nature, allowing farmers to choose from a wide range of resources without adversely affecting their financial standings. In India, there was an organized effort to increase agricultural credit through a supply-driven approach. Farmers in India have a choice between institutional and non-institutional forms of credit. Among the formal sources of credit are commercial banks that provide long-term, short-term and medium-term loans. Bank loans are subject to a number of conditions, including documentation of agricultural land and credit report from the financial institution. The informal credit market includes a number of ways to get credit and include borrowing from friends and relatives and working with middlemen or commission agents. When the need arises suddenly, agents lend money to farmers; they then sell their crops to the same commission agent at a higher price, even if it is a verbal agreement. Farmers borrow money to cover their farming costs. Credit from banks to agriculture has two broad classifications: Direct finance and indirect finance. Direct finance is the kind of loan in the agricultural sector that directly impacts the agricultural production system and Indirect finance is the type of agricultural finance that is for agricultural input sub-system, for example, lending to public utility boards, financing fertilizers distribution, pesticides distribution etc. The share of direct credit to agriculture derived from short-term loans or credit for short-term seasonal agricultural production has been significant in recent years. The All-India Rural Credit Review Committee (1969) proposed a "multiagency approach" in order to boost agriculture and rural credit. Commercial banks were expected to provide more credit to help the rural economy. Since 1969, when commercial banks were nationalized, the government has increased their proactive efforts in credit expansion for agriculture. During this time, the Reserve Bank of India introduced the concept of a lead bank; Banks were expected to focus on specific geographical areas to help promote overall rural development within its area of operation and to increase the flow of credit to agriculture. Reserve Bank of India (RBI) increased collateral-free agriculture loan limits to increase access to formal credit for small and marginal farmers. Reserve Bank of India continued to work towards increasing financial inclusion to unbanked rural areas and making credit more accessible. In fulfilling its role of development, the Reserve bank of India places a high priority on thorough and efficient financial services, particularly in the priority sectors of the economy, including agriculture, micro-businesses, and the weaker sections of society. Recent years have seen an increase in agricultural credit as a percentage of both inputs and output. Scheduled commercial banks are increasing credit to agriculture through disbursements of agricultural credit. There was an unprecedented increase in institutional credit in rural areas and a variety of services were initiated after a series of policies and procedures aligned with the priorities of the priority sector lending of the economy. Institutional credit in rural areas has grown rapidly as a result of policies and procedures tailored for rural priorities. Microfinance, Service Area Approach and Kisan Credit Cards have also been implemented to increase the availability of agricultural credit. Deregulation of financial markets and globalization has led to new challenges and opportunities. Credit assists in boosting primary production through the purchase of high-quality seeds, fertilizers, investment in farm equipment, and facilitating export. A new bank network was created to strengthen rural credit delivery mechanisms along with the government's institutional expansion policy. As a result of the expansion of institutionalization coupled with the development of new banking networks, rural credit has been strengthened. Increases in agricultural credit have been attained through a supply-led approach. The objectives have been to replace moneylenders and relieve farmers of their debt. This approach also aims at increasing levels of agricultural investment, agricultural credit and agricultural output.

5.2 Effectiveness of Agricultural Credit on Input Consumption

Increased reliance on agricultural inputs, technological changes and efficiency of production are three factors that are significantly associated with agricultural growth. Agriculture credit, in combination with modern technology, seems to be a critical input for higher productivity among small farmers, since their savings are negligible. Credit is a sub-component of total investments made in agriculture, so its increased supply and administered pricing can increase productivity and well-being. Over the last three decades, it has become evident that credit is not only being obtained by small and marginal farmers for survival, but also by the larger farmers in order to enhance their income. Increased credit supply for farmers facing credit constraints can raise input use, investment and output. Better credit facilities can smooth consumption in developing countries where agriculture is still a risky activity. As a result, risk-averse farmers may take on more risk and invest in agriculture. In the process, credit has become an important element in agricultural development strategy since independence. The agricultural credit market in India is a combination of informal and formal sources of credit. The share of agricultural credit as the value of inputs and outputs has been increasing over the past years. The banks provide more loans in areas with good agricultural prospects, thus reducing the risk and enhancing chances for loan recovery.

Most farming is done by cultivating crops with the use of subsequent inputs, including seed, electricity, farming machinery, fertilizers, pesticides, and so on. In agricultural production and productivity, the seed is considered as an essential input. The quality of seeds and other agricultural inputs have a direct effect on the efficiency of other inputs, such as fertilizers, pesticides, irrigation, etc. With electricity becoming increasingly important for farms in all parts of the country, farmers are turning to it for a source of power. Generally, electric power is used for irrigation and domestic water supply in rural areas. Harvesting and threshing are also done with electric power and tractor power. Chemical fertilizers replenish soils with nutrients, making them essential inputs in agriculture. Their importance cannot be underestimated while striving to attain self-sufficiency with regards to food production. Use of Pesticides has become increasingly important to implement plant protection strategies and activities for environment friendly and sustainable agriculture. By using machinery on farms, farmers are not only able to use resources more efficiently, but they also save valuable time and reduce the need for repetitive labour.

Table5.1: Correlation Matrix of Agricultural Inputs and Agricultural Credit

	ELEC	FER	IDC	SEE	TDC	TL	TRAC
ELEC	1.00						
FER	0.89	1.00					
IDC	0.89	0.82	1.00				
SEE	0.94	0.95	0.92	1.00			
TDC	0.93	0.88	0.96	0.98	1.00		
TL	0.90	0.96	0.88	0.97	0.92	1.00	
TRAC	0.95	0.93	0.91	0.98	0.96	0.97	1.00

Source: Author's Own Calculation

The correlation matrix is used to estimate linear associations between two variables. The linear correlation coefficient between two variables is equal to -1 for a perfectly negative correlation, 0 for no correlation and 1 for a perfectly positive correlation. The correlation matrix in Table 5.1 shows correlation coefficients between the variables Electricity consumption in agriculture (ELEC), Fertilizers utilized in agriculture (FER), indirect credit to agriculture (IDC), Seeds used in agriculture (SEE), Total Direct credit to agriculture (TDC), Power tillers used for agriculture purpose (TL) and Tractors used for agriculture purpose (TRAC).

For the variables mentioned in the table, indirect credit to agriculture has a correlation coefficient of 0.82 to 0.96. This indicates that all the variables are positively correlated to the indirect credit supplied to agriculture by commercial banks. Having a coefficient of about 0.92, indirect credit has a strong correlation with seeds. The coefficient of indirect credit for tractors is 0.91, the coefficient for electricity is 0.89, the coefficient for power tillers is 0.88, and the coefficient for fertilizer is 0.82.

Direct credit to agriculture has a correlation coefficient ranging from 0.88 to 0.98 for the variables mentioned in the table. As a result, variables are positively correlated with the supply of direct agricultural credit by commercial banks. A close correlation exists between direct credit and seeds because the coefficient value of seeds is near 1. With respect to direct credit, tractors have an estimated coefficient of 0.96, electricity has an estimated coefficient of 0.93, power tillers have an estimated coefficient of 0.92, and fertilizers have an estimated coefficient of 0.88.

There is a strong correlation between all inputs in agriculture, including fertilizers, seeds, power tillers and tractors with commercial bank credit to the agricultural sector. The correlation matrix clearly shows that these five inputs are highly positively correlated with total direct credit. Moreover, this indicates that the independent and dependent variables in this study were selected fairly well.

5.2.1 Direct Credit and Agricultural Input Usage

MODEL: 5.1
$LOG\ (TRAC) = \alpha_0 + \alpha_1\ LOG\ (TDC) + \mu_1$
Dependent Variable: Tractors (TRAC)
Independent Variable: Total Direct Credit (TDC)

MODEL: 5.2
$LOG\ (SEE) = \alpha_0 + \alpha_1\ LOG\ (TDC) + \mu_1$
Dependent Variable: Seeds (SEE)
Independent Variable: Total Direct Credit (TDC)

MODEL: 5.3
$LOG\ (FER) = \alpha_0 + \alpha_1\ LOG\ (TDC) + \mu_1$
Dependent Variable: Fertilizers (FER)
Independent Variable: Total Direct Credit (TDC)

MODEL: 5.4
$LOG\ (ELEC) = \alpha_0 + \alpha_1\ LOG\ (TDC) + \mu_1$
Dependent Variable: Electricity Consumption (ELEC)
Independent Variable: Total Direct Credit (TDC)

MODEL: 5.5

LOG (TL) = α_0+ α_1 LOG (TDC) +μ_1

Dependent Variable: Power Tillers (TL)

Independent Variable: Total Direct Credit (TDC)

Description of Variables

- **Tractors (TRAC):** refers to the total numbers of tractors sold for use in agricultural sector. It is expressed in Numbers.
- **Seeds (SEE):** it refers to the sum of all seeds consumed in agriculture (breeder seeds, foundation seeds, and quality seeds). In this case, the value is expressed in lakh quintals.
- **Fertilizers (FER):** refers to the total quantity of fertilizers (nitrogenous, phosphatic and potassic) consumed in agriculture. The agricultural fertilizers are expressed as lakh tonnes.
- **Electricity (ELEC):** refers to the consumption of electricity for agricultural purpose. The unit of measurement is Gigawatt hours (GWh).
- **Power Tillers (TL)**: refers to the total numbers of power tillers sold for use in agricultural sector. It is expressed in Numbers.

Table 5.2: Impact of Direct Agricultural Credit on Agricultural Input

Model 5.1: LOG (TRAC) = α_0+ α_1 LOG (TDC) +μ_1							
Variable	Coefficient	Std.Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	8.377804	0.352	23.786	0.000	0.86	1.48	142.44
LOG(TDC)	0.367372	0.030	11.935	0.000			
Model 5.2: LOG (SEE) = α_0+ α_1 LOG (TDC) +μ_1							
Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	-0.332403	0.181678	-1.829625	0.0809	0.97	1.32	814.15
LOG(TDC)	0.453046	0.015878	28.53347	0.0000			
Model 5.3: LOG (FER) = α_0+ α_1 LOG (TDC) +μ_1							
Variable	Coefficient	Std.Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	2.8177	0.1469	19.174	0.000	0.92	1.57	265.17

LOG(TDC)	0.2091	0.0128	16.284	0.000			
Model 5.4: LOG (ELEC) = α_0+ α_1 LOG (TDC) +μ_1							
Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	9.242718	0.242499	38.11441	0.0000	0.78	1.25	822.09
LOG(TDC)	0.192158	0.021193	9.066971	0.0000			
Model 5.5: LOG (TL) = α_0+ α_1 LOG (TDC) +μ_1							
Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	4.075088	0.294282	13.84758	0.0000	0.94	1.89	394.85
LOG(TDC)	0.511058	0.025719	19.87104	0.0000			

Source: Author's Own Calculation

This study uses a bivariate regression model to estimate the effect of direct agricultural credit on input consumption. The regression model 5.1 identifies the impact of direct agricultural credit (independent variable) and tractor usage (dependent variable). The regression estimates suggest that tractor usage in the agricultural sector is positively and statistically significantly related to the direct agricultural credit lending by commercial banks in India. Tractor sales to the agricultural sector have a coefficient of 0.367, this implies that Increasing agricultural credit by one percent leads to a 0.36 percent rise in tractors usages in the agricultural sector. A significant impact is indicated by the t-value on the dependent variable. In this case, the value of R^2 is 0.86, which is quite satisfactory. The value of F-statistics is 142.44, which implies that the regression model as a whole is therefore statistically significant for explaining the dependent variable.

The above table demonstrates the seeds elasticity with respect to direct credit in the agricultural sector in India during 1991 to 2014. In the regression model, the independent variable (total direct credit by commercial banks) has a regression coefficient of 0.45. In this model, the estimated coefficient is statistically significant and shows a positive impact on the consumption of seeds in the agricultural sector. It indicates that increasing direct agricultural credit by commercial banks by one percent leads to a 0.45 percent increase in usages of high variety seeds. According to the F-statistics (value of F-statistics = 814.15), the overall significance weighs in favour of the model. Likewise, the R-square value is 0.97 which indicates a good fit. Durbin-Watson statistical behavior is also good, as its value of 1.32 indicates that there is no serious autocorrelation problem.

According to the coefficient for total direct credit for the agricultural sector, the effect of direct credit lent for agricultural purposes on fertilizer consumption in the agricultural sector is positive and significant at 5 percent significance level. A one percent increase in direct agricultural credit disbursements increased fertilizer use for agricultural purposes by 0.20 percent, as indicated by the value of the coefficient. Taking a look at the F-statistics (265.17), it is evident that the overall model is highly significant. In light of the coefficient of determination, it appears that approximately 92 percent of the variation in fertilizer consumption within the agriculture sector is attributable to the independent variable.

According to this estimate, the total direct credit coefficient is 0.19. It shows that an increase in agricultural direct credit by one percent results in an increase in electricity consumption for agricultural purposes by 0.19 percent. In other words, the greater the amount of direct agricultural credit provided by commercial banks, the more electricity will be used for agricultural purposes, which, in turn, will have an impact on agricultural productivity. The coefficient of determination (0.78) appears quite satisfactory, and the F statistics indicate that the model is overall significant.

Based on the data, it appears that agricultural direct credit plays a positive and significant role in explaining the use of power tillers in the agriculture sector. The estimated coefficient of the independent variable is 0.51, which implies that an increase of one percent in the direct agricultural credit by commercial banks leads to a 0.51 percent increase in the use of power tillers in agriculture. In addition, the coefficient of determination is 0.94 according to the results. It indicates that the explanatory variable explained the dependent variable to the tune of 94 percent. The F statistic for the overall model is 394.85, indicating that its significance is high. Durbin-Watson statistics indicate that there is no autocorrelation, which is desirable, as the value is 1.89.

5.2.2 Indirect Credit and Agricultural Input Usage

MODEL: 5.6

$\mathrm{LOG\ (TRAC)} = \alpha_0 + \alpha_1 \mathrm{LOG\ (IDC)} + \mu_1$

Dependent Variable: Tractors (TRAC)

Independent Variable: Total Indirect Credit (IDC)

MODEL: 5.7

$LOG\ (TL) = \alpha_0 + \alpha_1\ LOG\ (IDC) + \mu_1$

Dependent Variable: Power Tillers (TL)

Independent Variable: Total Indirect Credit (IDC)

MODEL: 5.8

$LOG\ (SEE) = \alpha_0 + \alpha_1\ LOG\ (IDC) + \mu_1$

Dependent Variable: Seeds (SEE)

Independent Variable: Total Indirect Credit (IDC)

MODEL: 5.9

$LOG\ (FERT) = \alpha_0 + \alpha_1\ LOG\ (IDC) + \mu_1$

Dependent Variable: Fertilizers (FERT)

Independent Variable: Total Indirect Credit (IDC)

MODEL: 5.10

$LOG\ (ELEC) = \alpha_0 + \alpha_1\ LOG\ (IDC) + \mu_1$

Dependent Variable: Electricity Consumption (ELEC)

Independent Variable: Total Indirect Credit (IDC)

Table 5.3: Impact of Indirect Agricultural Credit on Agricultural Input

Model 5.6: $LOG\ (TRAC) = \alpha_0 + \alpha_1\ LOG\ (IDC) + \mu_1$							
Variable	Coefficient	Std.Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	9.905041	0.288485	34.33467	0.0000	0.79	1.32	867.78
LOG(TDC)	0.262523	0.028181	9.315478	0.0000			
Model 5.7: $LOG\ (TL) = \alpha_0 + \alpha_1\ LOG\ (IDC) + \mu_1$							
Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	6.140815	0.269307	22.80232	0.0000	0.90	1.43	298.90
LOG(TDC)	0.371026	0.026308	14.10322	0.0000			

Model 5.8: LOG (SEE) = α_0+ α_1 LOG (IDC) +μ_1							
Variable	Coefficient	Std.Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	1.575444	0.254814	6.182719	0.0000	0.88	1.23	266.6
LOG(TDC)	0.321326	0.024892	12.90873	0.0000			
Model 5.9: LOG (FER) = α_0+ α_1 LOG (IDC) +μ_1							
Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	3.640189	0.109448	33.25954	0.0000	0.90	1.64	207.76
LOG(TDC)	0.154111	0.010692	14.41409	0.0000			
Model 5.10: LOG (ELEC) = α_0+ α_1 LOG (IDC) +μ_1							
Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	D-W	F-statistics
C	9.979713	0.160054	62.35201	0.0000	0.79	1.32	841.6
LOG(TDC)	0.143438	0.015635	9.174016	0.0000			

Source: Author's Own Calculation

The above regression results demonstrate the effect of indirect credit provided by commercial banks to the agricultural sector on tractor usages. The independent variable (indirect credit) has a value of 0.26. Findings of the regression estimations have indicated that indirect credit has a positive and significant relationship with tractor usage in the agricultural sector in India. Statistically significant effects are observed between the independent and dependent variable, based on the t-test. The R-squared value is 0.79. The F-statistic values indicate that the model is significant for a 5 percent significance level.

The above results depict the relationship between indirect credit lend by commercial banks to the agricultural sector and power tiller usage in the agricultural sector of India between 1991 and 2014. As the flow of total indirect credit to the agriculture sector by commercial banks increases, the usage of power tillers will also increase, which is indicated by the estimated value coefficient of 0.37, which is positive and significant at the 5 percent level. The value of F-statistics is 298.90. The value of R^2 is 0.90. There is no autocorrelation based on the D-W value of 1.43.

It is evident that the supply of indirect credit by commercial banks to the agricultural sector has positive effects in the sense that it enables increased use of high yield seeds to increase agriculture production in India. Further analysis of the results shows that indirect credit has a significant effect on seeds utilized in agriculture. The value of the estimated coefficient is 0.32. This implies that every one percent increase in indirect credit provided by commercial banks leads to a 0.32 percent increase in seeds that produce higher yields for increased productivity. In this model, 0.88 is the calculated coefficient of determination.

The indirect credit lent for agricultural purposes has a positive and significant impact on the consumption of fertilizer in agriculture. In this case, the coefficient of the disbursement of indirect agricultural credit is 0.15, which indicates that a one percent increase will result in a 0.15 percent increase in fertilizer use. According to the F-statistics (207.76), the overall model appears to be highly significant. As indicated by the coefficient of determination, around 90 percent of the variation in fertilizer consumption within agriculture can be attributed to the independent variable.

Using regression estimate, the coefficient of indirect credit is equal to 0.14. This indicates that increasing the indirect credit for agriculture by one percent leads to an increase in electricity consumption for agricultural purposes by 0.14 percent. The more indirect agricultural credit provided by commercial banks, the more electricity will be used for agricultural purposes, in turn impacting agricultural productivity with its results. In this model, F statistics show statistical significance, and the coefficient of determination measures quite favorably (0.79).

5.3 Impact of Total Direct and Indirect Credit on Agricultural Output (1991-2014)

A regression analysis of time series data with agricultural output as the dependent variable and long term, short term and total outstanding agricultural credit of scheduled public and private banks as the regressors to calculate the influence of commercial bank agriculture credit on agricultural output. The period of study is confined to 1991 to 2014.

MODEL: 5.11

LOG (AGDP) = α_0+ α_1 LOG (TDC) + α_2 LOG (IDC) +μ_1

Dependent Variable: Agricultural Gross Domestic Product (AGDP)

Independent Variable: Total Direct Credit to Agriculture (TDC)

Independent Variable: Total Indirect Credit to Agriculture (IDC)

Table 5.4: Impact of Total Direct and Indirect Credit on Agricultural Output (1991-2014)

Dependent Variable: LOG(AGDP)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.42426	0.120459	103.1412	0.0000
LOG(TDC)	0.084979	0.026553	3.200380	0.0043
LOG(IDC)	0.055365	0.019772	2.800166	0.0107
R-squared	0.963047	F-statistic		273.6485
Adjusted R-squared	0.959528	Prob(F-statistic)		0.000000
Durbin-Watson stat	1.173257			

Source: Author's Own Calculation

The results presented in the above table indicate the impact of total direct credit and total indirect credit supplied by scheduled commercial banks on agricultural output. The value of the estimated coefficient of total direct credit is 0.084. It shows that an increase in the total amount of direct credit by one percent leads to an increase in the agricultural output by 0.084 percent. The estimated coefficients of the independent variables are all statistically significant at the significance level of 0.05, and the theoretical expectations in terms of their signs are suitable. The model's estimation results suggest that the coefficient of total indirect credit is 0.055. Accordingly, an increase of one percent in agricultural indirect credits by commercial banks leads to an increase of 0.055 percent in agricultural output. The value of F - Statistics is 273.64, implies that the explanatory variables in the model altogether affect agricultural production in a significant way. The value of the coefficient of determination is 0.96; according to the model, the explanatory variables in the model explain approximately 96 percent of the variance of agricultural production. The regression coefficients suggest that total direct credit has a greater impact on agricultural output than total indirect credit. These results suggest that indirect credit is limited in its ability to increase agricultural output. Likewise, the poor performance of indirect credit in supporting agricultural growth stresses the need for proper targeting of direct and indirect credit to create the most beneficial effect possible on agricultural growth.

MODEL: 5.12

LOG (AGDP) = α_0+ α_1 LOG (TDC) + α_2 LOG (IDC_{t-1}) +μ_1

Dependent Variable: Agricultural Gross Domestic Product (AGDP)

Independent Variable: Total Direct Credit to Agriculture (TDC)

Independent Variable: Total Indirect Credit to Agriculture one year lag (IDC_{t-1})

Table 5.5: Impact of Total Direct and Indirect Credit on Agricultural Output (1991-2014)

Dependent Variable: LOG(AGDP)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.40871	0.123644	100.3582	0.0000
LOG(TDC)	0.103469	0.027362	3.781476	0.0012
LOG(IDC_{t-1})	0.037332	0.020661	1.806873	0.0259
R-squared	0.963494	F-statistic		263.9283
Adjusted R-squared	0.959844	Prob(F-statistic)		0.000000
Durbin-Watson stat	1.243914			

Source: Author's Own Calculation

The above table indicates the impact of direct credit (current period) and indirect credit (previous period; last 1 year) on the agricultural output of India. The estimated coefficient of direct credit is 0.103. The value of indirect credit with one year lag is 0.037. It indicates that increasing indirect credit, of the previous year, by one percent leads to a 0.037 percent increase in agricultural output of the current year. In the above table, it can be seen that indirect agriculture credit and its first lag are significant in describing the variation in agriculture output. The intervention through direct agriculture credit has a high and significant positive impact on agriculture output. Based on the results in the above table, direct agriculture credit is significant and positively explains the variation in agriculture output. The indirect agriculture credit amount is significant at the 5 percent level and positive at the first lag. It implies that the benefit of indirect financing for agriculture could lead to higher output next year. The value of F -Statistics is 263.92, the large value of the F-statistic shows that the variables included in the model impacted agricultural production significantly when taken all together. The value of R^2 is 0.96, which implies that the explanatory variables accounted for over 96 percent of the variance in agricultural production in the model and only 4 percent accounted for the error term.

MODEL: 5.13

LOG (AGDP) = α_0+ α_1 LOG (PBAGR) + α_2 LOG (PVAGR) +μ_1

Dependent Variable: Agricultural Gross Domestic Product (AGDP)
Independent Variable: Credit to Agriculture by Scheduled Public Sector Commercial Banks (PBAGR)
Independent Variable: Credit to Agriculture by Scheduled Private Sector Commercial Banks (PVAGR)

Table 5.6: Impact of Public and Private Sector Scheduled Commercial bank Agricultural Advances on Agricultural Output (1991-2014)

Dependent Variable: LOG(AGDP)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.33271	0.245732	50.18771	0.0000
LOG(PBAGR)	0.121629	0.041439	2.935156	0.0079
LOG(PVAGR)	0.025865	0.025429	1.017183	0.3206
R-squared	0.960141	F-statistic		252.9280
Adjusted R-squared	0.956345	Prob(F-statistic)		0.000000
Durbin-Watson stat	1.080419			

Source: Author's Own Calculation

The above table illustrates the impact of scheduled commercial public sector bank agricultural advances and private sector bank agricultural advances on the agriculture output. The coefficient of PBAGR (agricultural advances by public sector commercial banks) and coefficient of PVAGR (agricultural advances by private sector commercial banks) indicate that it has a positive relation with agricultural output. According to the estimated coefficient of PBAGR 0.121, it implies that an increase of one percent in agricultural advances by public sector commercial banks leads to 0.121 percent increase in agricultural output. The value of the estimated coefficient of PVAGR is 0.025, it indicates that increasing agricultural advances by private sector commercial banks by one percent leads to a 0.025 percent increase in agricultural output. The above results depict that public and private sector bank advances towards agriculture sector has positive influence on the variation in agriculture output, but the intervention of agricultural credit through public sector banks has a high and significant positive impact on agriculture output. Based on the results in the above table, t-value indicates that only Public sector commercial banks agricultural advances as an independent variable is significant at the 5 percent significance level. The F test for the overall model also indicates that it is highly significant, F=252.92 at significance Prob. F =0.000. The R-squared value is a measure of how well independent variables can explain the variance in the dependent variable. In regression analysis, R^2 is the goodness-of-fit measure. The value of R^2 is 0.96, which implies that over 96 percent variations in the agricultural output were explained by the independent variables collectively and only 4 percent accounted for the error term. So it's clear from empirical evidence that including farmers in the formal financial system boosts agriculture output.

MODEL: 5.14

$LOG(CROP) = \alpha_0 + \alpha_1 LOG(PBAGR) + \alpha_2 LOG(PVAGR) + \mu_1$

Dependent Variable: Agricultural Crop Product (CROP)
Independent Variable: Credit to Agriculture by Scheduled Public Sector Commercial Banks (PBAGR)
Independent Variable: Credit to Agriculture by Scheduled Private Sector Commercial Banks (PVAGR)

Table 5.7: Impact of Public and Private Sector Scheduled Commercial bank Agricultural Advances on Agricultural Crop Production (1991-2014)

Dependent Variable: LOG(CROP)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.07957	0.266377	45.34769	0.0000
LOG(PBAGR)	0.094481	0.044920	2.103305	0.0477
LOG(PVAGR)	0.040110	0.027565	1.455119	0.1604
R-squared	0.951208	F-statistic		204.7009
Adjusted R-squared	0.946562	Prob(F-statistic)		0.000000
Durbin-Watson stat	1.416088			

Source: Author's Own Calculation

The above table illustrates the impact of agricultural credit issued by scheduled commercial public and private sector banks on the agricultural crop production in India. Credit from scheduled commercial banks positively affects agricultural crop production over the period of the study (1991-2014). According to the coefficient of the independent variable PBAGR, PVAGR and agricultural crop production exhibit a positive and statistically significant relation, according to statistics, at a five percent significance level. Meanwhile, the coefficient of independent variable PVSB (private sector scheduled commercial banks) shows a positive relationship with agricultural crop production but is statistically insignificant. The estimated coefficient of PBAGR is 0.0944, it indicates that an increase of one percent in agricultural loans by these banks increases crop production by 0.094 percent. The estimated coefficient of PVAGR is 0.040, which indicates that if private sector commercial bank credit is increased by one percent, there will be an increase of 0.040 percent in agricultural crop production. The results indicate that both private commercial bank credit and public commercial bank credit for the agriculture sector contribute positively to crop production variation, however, agricultural credit delivered by public sector commercial banks seems to have a significant, positive influence on crop production. t-value shows that the independent variable public sector commercial bank is significant at a significance level of 5 percent based on results presented in the above table. According to the F test, the overall model is also significant, F =204.700 at a Prob(F-statistics) = 0.000. R2 is 0.95, which indicates that more than 95 percent of the variations in agricultural crop production can be explained by the independent variables.

5.4 Evaluating Output Elasticity in Agriculture

The Cobb-Douglas production function has been devised to obtain a general understanding of the relationship between outputs and inputs, as well as on the characteristics of technological changes. The estimation parameters of this production function are simple to compute, interpret and comply with the fundamental economic laws. In Cobb-Douglas Production Function, coefficients are used to estimate percent increase in output resulting from a one percent increase in input while keeping the other inputs constant.

The production function is:

$$N = f(l, L, K)$$

The above equation indicates the functional relationship between input and output.

$$N = A\, l^{\alpha 1}\, L^{\alpha 2}\, K^{\alpha 3}$$

The linear form is converted to its logarithmic counterpart by taking the logarithm on both sides of the above equation:

$$Log\,(Q) = Log\,(A\, l^{\alpha 1}\, L^{\alpha 2}\, K^{\alpha 3})$$
$$= log\, A + log\,(l^{\alpha 1}) + log\,(L^{\alpha 2}) + log\,(K^{\alpha 3})$$
$$= log\, A + \alpha_1 log\, l + \alpha_2 log\, L + \alpha_3 log\, K$$

A log-linear form, however, uses the exponent as a parameter. Log A is the intercept, and α_1, α_2 and α_3 are the slopes of land, labour and credit in this log-linear equation. In this model, α_1, α_2 and α_3 are positive parameters where the values of these parameters are greater than zero.

The time variable is used in the above log-linear equation to estimate technical progress or technical change per period:

$$Log\,(N) = log\, A + \alpha_1 log\, l + \alpha_2 log\, L + \alpha 3 log\, K + \lambda\, t + \mu_1$$

$$Log\,(Agricultural\ output) = log\, A + \alpha_1 log\,(land) + \alpha_2 log\,(agricultural\ workers) + \alpha_3 log\,(Credit) + \lambda\,(time) + \mu_1$$

Where,
N= Agricultural Output, l = Gross Cropped Area,
K =Agricultural credit by Commercial Banks
L= Workers engaged in Agricultural Sector
A= Efficiency Parameter
α_1 = Coefficient of Land
α_2 = Coefficient of Labour
α_3 = Coefficient of Credit
μ_1 = Error Terms
λ t = Change in Output as a Proportion of Time

The following table presents Cobb-Douglas Production Function results from 1991 to 2014. The constant term, coefficients of land (α_1), labor (α_2), credit (α_3), coefficients of the time variable, coefficient of determination, Durbin Watson statistic, and F-statistics are included in the table.

Table 5.8: Production and Agricultural Inputs: An Analysis of Agricultural Credit

Variables	Estimated Coefficient of Variables	P-value
Constant (α_0)	-4.1261	0.0412

LOG LAND (α_1)	1.095	0.0001
LOG LABOR (α_2)	0.5691	0.0303
LOG CREDIT (α_3)	0.0380	0.0149
TIME A (t)	0.0168	0.0041
Durbin-Watson stat	2.46	-
R-squared	0.98	-
F-statistic	339.15	0.000
Efficiency A	0.0161	-
Distribution $\alpha_1 = \alpha_1 / \alpha_1 + \alpha_2 + \alpha_3$ $\alpha_2 = \alpha_2 / \alpha_1 + \alpha_2 + \alpha_3$ $\alpha_3 = \alpha_3 / \alpha_1 + \alpha_2 + \alpha_3$	0.643 (α_1) 0.334 (α_2) 0.022 (α_3)	-
Technical Progress	1.68	-

Source: Author's Own Calculation

5.4.1 Agricultural Output and Land Elasticity (α_1):

Net cultivated land area tended to have a positive coefficient according to the results, which means that any change in net cultivated land area increases agriculture productivity. Agricultural output elasticity with respect to land is 1.095, which is positive and statistically significant at the 5 percent level. Estimate for α_1 of 1.095 shows that an increase of one percent in cultivated land area leads to an increase of 1.095 percent in the output level, assuming that all other inputs remain constant. This indicates that the returns to land are increasing.

5.4.2 Agricultural Output and Labour Elasticity (α_2):

A positive coefficient of labour is statistically significant at 5% significance level. Results show that there is a positive relationship between the labour force and agricultural output. The value of coefficient α_2 is 0.5691, indicates that an increase in labor supply of one percent increases agricultural output by 0.5691 percent, keeping all other inputs constant. It indicates the elasticity of output with respect to labor which is less than one.

5.4.3 Agricultural Output and Credit Elasticity (α_3):

Based on the results in the table 5.8, the coefficient of credit is positive and significant; that is, any change in the credit as input to agriculture will positively influence agricultural output. Based on the significance level of 5 percent, the output is statistically significant and is positive in relation to the credit, with an elasticity of 0.0380. In other words, an increase of one percent in credit as input leads to an increase of 0.0380 percent in agricultural output, holding other inputs constant.

The results in the table 5.8 reveal that agricultural output is positively correlated with certain agricultural inputs, such as land, labour and credit. The results of the above table also suggest that output is highly responsive to land and labour inputs. For the agricultural sector, the estimated return to scale is 1.70, indicating that an increase of one percent in agricultural inputs specified in the above table will result in an increase in output by 1.70 percent. The land has an elasticity of 1.095, labour has an elasticity of 0.5691, and credit has an elasticity of 0.0380. There is a combined elasticity of 1.70 for all three inputs. Land and labour have a combined elasticity of 1.66, a little scope is left for credit. This is one of the most valuable findings that indicate agriculture is a labour and land intensive sector. Based on the variable Time held constant, the estimated growth rate is 1.68 percent annually, indicating a positive technological change in the agricultural sector. F-test for the overall model, F = 339.15, indicates high significance for the model at sig F= 0.0000. According to the results of the t-test for independent variable significance in the model indicate that all of the independent variables are significant at the significance level of 5 percent. The R^2 value is 0.98, this suggests that around 98 percent of the variation in agricultural output can be attributed to the independent variables combined. A significant Durbin-Watson statistic value indicates that there is no autocorrelation among the residuals.

Summary of Results

Impact of Independent variable on dependent variable

Dependent Variable	Independent Variable	Degree of Impact
TRAC	TDC	0.367
SEE	TDC	0.453
FER	TDC	0.209

ELEC	TDC	0.192
TL	TDC	0.511
TRAC	IDC	0.262
TL	IDC	0.371
SEE	IDC	0.321
FER	IDC	0.154
ELEC	IDC	0.143
AGDP	TDC	0.084
AGDP	IDC	0.055
AGDP	$IDC_{(t-1)}$	0.037
AGDP	PBAGR	0.121
AGDP	PVAGR	0.025
CROP	PBAGR	0.094
CROP	PVAGR	0.040
AGRICULTURAL OUTPUT (N)	LAND	1.095
AGRICULTURAL OUTPUT (N)	LABOR	0.569
AGRICULTURAL OUTPUT (N)	CREDIT	0.038

Source: Author's Own Calculation