A Study on interlinkage between Rural Infrastructures and Agricultural Land Productivity of Assam

Jayashree Bordoloi
PhD Research Scholar
Department of Business Administration
Tezpur University, Tezpur, Assam, India, 784028
Email- bordoloijayashree701@gmail.com

Abstract: Rural infrastructure is a powerful tool in strengthening the foundation of agriculture which is a pace setter for economic growth. Poor physical infrastructure in Assam acts as roadblocks imbalancing the socio-economic development that leads to other social and economic issues. The infrastructure development of an economy includes both economic and social infrastructure. The paper attempts to portray a linkage between the infrastructure development and agricultural productivity by analyzing the impact of infrastructures on agricultural land productivity. The study however aims to answer the following research questions - Is there any possibility of rural infrastructure influencing the agricultural productivity significantly? If yes, which type of infrastructure influences and at what level of significance does infrastructure impacted on productivity?

Keywords: Rural infrastructure, productivity, economic growth.

I. INTRODUCTION

The meaning of the term ‘infrastructure’ in literal sense means the basic physical and organizational structure needed for operation of a society or enterprise. In Keynesian economics, the term infrastructure has been used to describe the public assets that facilitate production, but not the private assets of the same sense (Chandrachud and Gajalakshmi, 2015). There is a precise link between infrastructure and development. Infrastructure investment directly affects the economic development. Many studies have found a positive relationship between the level of economic development and quality of housing access to basic amenities like electricity, safe drinking water, irrigation, toilets etc (Srinivasu and Rao, 2013). Recent literature indicates the significant role played by rural infrastructure in improving agricultural productivity in developing economies. Research shows that productivity increase in agriculture, which is an effective driver of economic growth and poverty reduction, depends on good rural infrastructure, well-functioning domestic markets, appropriate institutions, and access to appropriate technology (Andersen and Shimokawa, 2007; Llanto, G. 2012). Significant increase in investment in rural infrastructure would help increase production and consumption, decrease malnutrition, and increase livelihood security. Poor transport infrastructure limits market access for many farmers in the developing countries (Ashok and Balasubramanian, 2006). The performance of infrastructure reflects the performance of an economy. Development of infrastructure is very much necessary especially in the rural areas as they are the driving force of productivity increment and reduction in poverty. Agriculture sector which holds primary importance in rural areas, has been performing relatively poorer compared to the other sectors. Infrastructure is particularly crucial and relevant to the small farmers in the developing countries where the size holdings are small and traditional crops with low productivity are not capable of providing sufficient income and employment to the population dependent on agriculture sector.

II. LITERATURE REVIEW

Majumdar (2002), on the basis of regression analysis of the State-level cross-section data for the years 1971-1995 indicated that among various physical infrastructures, it was the transport infrastructure that significantly affected the agricultural output level and agricultural development index. Physical and social infrastructure also had a significant positive impact on the dependent variables. According to Nadeem et.al (2011), in the paper entitled, 'Impact of Social and Physical Infrastructure on Agricultural Productivity in Punjab, Pakistan – A Production Function Approach,’ public investment acts as an important factor of rural infrastructure that helps to increase agriculture on one hand and reduces poverty on the other. Based on secondary data the study measured the impact of public infrastructure taking social and physical infrastructure investment on total factor productivity (TFP) using TFP as the dependent variable in Punjab, Pakistan using the methodology of multivariate Cobb Douglas Production function for the period 1970-2005. As per the results the study concludes that the public investment on physical infrastructure such as rural roads, village electrification and irrigation and social infrastructure involving rural education and rural health have contributed a positive significant impact to TFP. The study also ends with the suggestive comment that more resources should be contributed towards the development of physical and social infrastructure that will increase the agricultural productivity and reduce the rural poverty as well. A study on the ‘Impact of Road Infrastructure on Agricultural Development and Rural Road Infrastructure development programmes in India’ by Lokesha and Mahesha
Based on descriptive research, found that rural roads are the major source of connectivity, assets of a nation, a tool for social inclusion, economic development, and environmental sustainability. Improving rural roads reduces transportation costs and encourages marketing, which results in increased production and productivity, crop diversification, and increased profitability. Chandrachud and Gajalakshmi (2015), in their study, investigated that economic infrastructure and social infrastructure can be achieved through developing various sectors like energy, power, telecommunication, transport, irrigation, etc. as well as education infrastructure development and health infrastructure development. The paper has provided a linkage between the infrastructure development and the Agricultural sector through the transition of tradition agriculture sector into commercialised agriculture sector and found that the agriculture sector had low production due to a number of factors such as illiteracy, insufficient finance, and inadequate marketing of agricultural products. The relationship between them is supported by undertaking the current status of economic infrastructure, social infrastructure, and role of infrastructure development in agricultural growth. Baba et al. (2015), using the regression model, analysed the growth and impact of rural infrastructure on agricultural land and labour productivity in Jammu & Kashmir employing secondary data. The study mainly examined undertaking five infrastructure variables, namely, road, irrigation, village electrification, institutions, and cooperatives. The result indicated that the estimates of agricultural land and labour productivity model have significantly contributed to the growth of agricultural productivity. Based on major findings, the study suggests that the progress of growth in development of the rural areas as well as the agricultural economy has to be accompanied by consistent growth in rural infrastructure to maintain a stationary balance growth in the economy. Singh and Kaur (2014) in their paper entitled 'Role of Infrastructure in the Growth of Agriculture in Punjab' investigated the relationship between institutional Agri-infrastructure and volume of agriculture production through coefficient of correlation analysis. Based on the secondary data, the study undertook the time period from 1990-91 to 2011-12 and revealed that the financial institutions both the formal and informal institutions have played a dominating role in increasing the volume of agriculture followed by number of regulated markets and total storage capacity with Govt agencies accreditation. The study also established a strong relationship between institutional Agri-infrastructure and volume of agriculture production.

III. OBJECTIVES

To present study aims at analyzing the impact of infrastructural indicators on agricultural productivity across different districts of Assam. On this backdrop, the researcher aims at answering the following research questions:

1. Is there any possibility of rural infrastructure influencing the agricultural productivity significantly?
2. If yes, which type of infrastructure influences and at what level of significance does infrastructure impact productivity?

IV. METHODOLOGY

IV.1 Profile of the Study area:

Assam a North Eastern state of India is covered with a geographical area of 78438 sq. km i.e., about 2.4% of the country’s total geographical area. The state of Assam presents to be a good case for measuring the impact of infrastructure on agricultural productivity as the percentage of gross cropped area in the state has constantly increased from 2012-13 with 96.03% to 99.02% in 2014-15 with a slight decline during 2015-16 with 98.32%. In spite of the fact, it is noticed that only three districts i.e., Karbi Anglong, Chirang, and Udalguri shows an increased percentage of gross cropped areas while in case of the other districts the percentage of gross cropped area decreased or remains the same may be due to the nature and unavailability of irrigation and infrastructural facilities in the respective districts.

The notable fact of Assam’s economic development is that it is falling behind the rest of the major states of the country. Assam’s economy is fundamentally based on agriculture. Over 75% of the state’s population depends on agriculture for their livelihood. Total land under cultivation was 2.83 million hectares in 2014-15 which almost covers 36% of total geographical land area of the state. The average size of land holdings was only 1.10 hectares during the year 2014-15 and more than 85% of farmer families are either small or marginal farmers with average land holding of only 0.63 hectare. However, as agriculture supports more than 75% of its population, either directly or indirectly, it provides employment and support to more than 50% of its total workforce. Assam has a rich soil condition, very conducive for agricultural productivity. But due to the unavailability of infrastructure and unpredictable weather conditions, along with erratic rainfall and the presence of various constraints like floods, soil erosion etc., agricultural productivity has been suffering. The development of agriculture sector in hill districts of the state, namely East Karbi-Anglong, west Karbi-Anglong and Dima-Hasao are suffering due to presence of various weaknesses of low infrastructural facilities. Therefore development of agriculture facilities in these hilly areas needs attention for infrastructural development and access to markets. The present study analyses the impact of infrastructural indicators on agricultural productivity.
across the districts of Assam. The study attempts to analyse how different types of infrastructural indicators have impacted the agricultural productivity taking (2016-17) time period across different districts in Assam. Along with infrastructure, other inputs like HYV, consumption of fertilisers and the achievement of KCC scheme variables are also been taken as the independent variable which act as the driving force of agricultural development in the study.

IV.2 Sources of Data:

A cross section data have been undertaken to study the impact of infrastructures on agricultural land productivity of Assam. Most of the data on infrastructural development indicators for the different states were collected from RBI Data, Economic survey of India, Directorate of Economics and Statistics and Agricultural report at a glance. Data on agricultural development indicators for the districts were collected from various sources such as Statistical Handbook of Assam, population census, Department of Agriculture and Cooperation, economic survey of Assam, NEDFI report. As the study is based on a cross section data the district level data is compiled mainly for the period 2016 in order to know the performances of the infrastructural development in different districts investigating the phenomenon behind the impact of various infrastructural indicators on agricultural productivity for the 26 districts of Assam. Out of 33 districts only 26 districts are taken into the study due to the unavailability of reliable data. Published literature in the form of books, booklets and articles on infrastructure development were used to provide a general background of the study.

IV.3 Analytical tools:

An attempt is made to prepare a methodology of the present study with the availability of important infrastructure variables to study the impact of rural infrastructural variables on agricultural land productivity in Assam, a north-eastern state. The study adopts a linear regression model using a simple OLS method to specify the significant impact of infrastructure variables on land productivity. Linear regression model is used to study the relationship between the variables by fitting a linear equation model to observe the data consisting of the endogenous variable and exogenous variables. Many studies have used the regression model to study the impact of rural infrastructures (Ghosh and De, 1998; Majumdar, 2002; Baba et al. 2015; Barnes andBinswanger, 1986) and found that it is the availability of physical, social as well as institutional infrastructure that affects the agricultural output level and agricultural development index significantly. Therefore, the present study is confined to use the linear regression model on measuring the impact of rural infrastructures on agricultural productivity.

Again, on estimating the endogenous variable, the agricultural land productivity is being used as the dependent variable in fitting the linear model. Many studies uses the Total Factor Productivity (TFP) on capturing the dependent variable but the TFP is not measured by input factors but the combination of technical progress and technical efficiency with which factors are used to produce output (Ashok and Balasubramanian, 2006). Also TFP does not indicate a good sign to capture the dependent variable because TFP mainly uses the attributes of the workforce or technical efficiency rather than the output of major rural infrastructure. Therefore, the agricultural land productivity is proposed to use as the dependent variable on the present study. The agricultural land productivity is calculated as- (Value of output / agricultural land) in Rs per hectare of net sown area.

Since Rice is the main cultivation of Assam, the study undertakes only the paddy crop (autumn, winter, summer) for the measurement of productivity. The prices of the output for the reference year 2016-17 have been taken for this purpose. A district level cross section data is carried and out of 33 districts a sample of 26 districts of Assam is undertaken in the study as per the availability of data. The nine infrastructure parameters were taken in the study i.e., irrigation, road, villages electrified, financial system, agricultural credit, primary schools, primary health centres, fertiliser consumption and HYV seeds as per the availability of the data.

IV.4 Selection of various infrastructural indicators:

Three classifications of infrastructures are undertaken in the study- the economic or physical, institutional, and social infrastructures. Each type of infrastructure indicator is measured by the area, by population or by percentages. Also as per the literature review (Nadeem et al. 2011; Majumdar 2002) the economic infrastructure like irrigation, roads, electricity are the main core areas for the rural development in any region and contributes significant impact on productivity. The indicators of the social infrastructure and the institutional infrastructure are being taken based on the literature review (Sidhu et al. 2008; Singh and Kaur 2014) which is directly or indirectly related to agricultural productivity and thus proves to show significant impact on the productivity.
In the present study, the variables used in the analysis to capture the infrastructural indicators of agricultural and infrastructural development is described as follows- In order to measure the physical or economic indicator, the ratio of gross irrigated area to net irrigated area is being used to capture the irrigation intensity. A percentage of villages electrified are used to measure the electricity infrastructure. The road transportation is being measured by the total road length per 100 sq km of geographical area. In case of social infrastructural indicator, availability of the number of primary schools and number of Health Centres per 100 sq. km of geographical area is being taken into the study. Institutional infrastructure also plays an important impact which cannot be ignored in the study and is measured with the availability of the number of banks per 100 sq km of geographical area and the credit from agricultural cooperatives is also taken into the study captured by the percentage of achievement under the KCC scheme which is a very important tool of the agricultural productivity in the rural areas at present. The study takes into account two other variables acting as a substitute of agricultural infrastructure that is, fertiliser consumption in kg per hectare of total cropped area and percentage of area under HYV to net sown area.

### Table: 1 Variables undertaken to measure the impact of land productivity.

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Variables undertaken</th>
<th>Undertaken to measure the impact of land productivity.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Irrigation</td>
<td>Ratio of gross irrigated area to net irrigated area</td>
</tr>
<tr>
<td>2.</td>
<td>Electricity</td>
<td>Percentages of villages electrified.</td>
</tr>
<tr>
<td>3.</td>
<td>Road Transport</td>
<td>Total road length per 100 sq. km of geographical area</td>
</tr>
<tr>
<td>4.</td>
<td>Education</td>
<td>Number of primary schools per 100 sq. km of geographical area</td>
</tr>
<tr>
<td>5.</td>
<td>Health</td>
<td>Number of health centres per 100 sq. km of geographical area</td>
</tr>
<tr>
<td>6.</td>
<td>Banks</td>
<td>Number of banks branches per 100 sq. km of geographical area</td>
</tr>
<tr>
<td>7.</td>
<td>Agricultural credit</td>
<td>Percentage of achievement under KCC scheme</td>
</tr>
</tbody>
</table>

Source: Researchers classification.

### IV.5 Model Specification:

The following structural form of the regression model has been constructed to measure the impact of rural infrastructures on land productivity.

\[ Y = F (IRR, ROD, ECT, EDN, HLT, BNK, ACR, FRT, HYV) \]

i.e., Y is assumed to be dependent on the values of IRR, ROD, ECT, EDN, HLT, BNK, ACR, FRT, HYV

Thus, the linear formulation of the function can be written as

\[ Y_i = \alpha + \beta_1 (IRR_i) + \beta_2 (ROD_i) + \beta_3 (ECT_i) + \beta_4 (EDN_i) + \beta_5 (HLT_i) + \beta_6 (BNK_i) + \beta_7 (ACR_i) + \beta_8 (FRT_i) + \beta_9 (HYV_i) + U_i \]  

(1)

We get our linear regression model as ……

\[ Y_i = \alpha + \beta_1 (IRR_i) + \beta_2 (ROD_i) + \beta_3 (ECT_i) + \beta_4 (EDN_i) + \beta_5 (HLT_i) + \beta_6 (BNK_i) + \beta_7 (ACR_i) + \beta_8 (FRT_i) + \beta_9 (HYV_i) + U_i \]  

(2)

Now, if we log transform the above model (2) we obtain:

\[ \ln (Y_i) = \alpha + \beta_1 \ln (IRR_i) + \beta_2 \ln (ROD_i) + \beta_3 \ln (ECT_i) + \beta_4 \ln (EDN_i) + \beta_5 \ln (HLT_i) + \beta_6 \ln (BNK_i) + \beta_7 \ln (ACR_i) + \beta_8 \ln (FRT_i) + \beta_9 \ln (HYV_i) + U_i \]  

(3)
In the above log linear model, $Y$ is the agricultural land productivity taken as the dependent variable and the coefficients of the model $\beta_1, \beta_2, \ldots, \beta_9$ implies the marginal impact of the independent variables (IRRI, ROD, ECT, EDN, HLT, BNK, ACR, FRT, HYV) on agricultural land productivity i.e., $Y$.

$U_i$ is the Random disturbance term which takes smaller value with higher probability and “i” stands for the subscripts taken for various districts that means (1,2,……..26).

Here, it is assumed that productivity provides a better analytical and empirical framework for studying the impact of the rural infrastructure in the agricultural sector and therefore agricultural land productivity has been specified as endogenous variable in the above linear equation (2). The model is estimated in log linear form with a research question that every selected infrastructure variable has a positive influence on agricultural productivity and which type of infrastructure has the highest significant on the agricultural land productivity.

The table 2 below presents the summary statistics of the development indicators of agricultural variables used in the study i.e., the mean, maximum, minimum and the standard deviation.

### Table 2: Description of variables and Expected sign of Coefficients:

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Variable Description</th>
<th>Descriptive Statistics</th>
<th>Expected sign of coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRRI</td>
<td>Ratio of gross irrigated area to net irrigated area</td>
<td>Mean: 4.87, Min: 4.60, Max: 5.29, SD: 0.22</td>
<td>+</td>
</tr>
<tr>
<td>ROD</td>
<td>Total road length per 100 sq. km of geographical area</td>
<td>Mean: 4.05, Min: 3.42, Max: 4.67, SD: 0.35</td>
<td>+</td>
</tr>
<tr>
<td>ECT</td>
<td>Number of villages electrified per thousand hectare of geographical area</td>
<td>Mean: 4.62, Min: 4.39, Max: 5.47, SD: 0.25</td>
<td>+</td>
</tr>
<tr>
<td>EDN</td>
<td>Number of primary schools per 100 sq. km of geographical area</td>
<td>Mean: 4.01, Min: 2.73, Max: 4.60, SD: 0.48</td>
<td>+</td>
</tr>
<tr>
<td>HLT</td>
<td>Number of primary health centres per 100 sq. km of geographical area</td>
<td>Mean: 0.28, Min: -1.49, Max: 1.85, SD: 0.65</td>
<td>+</td>
</tr>
<tr>
<td>BNK</td>
<td>Number of bank branches per 100 sq. km of geographical area</td>
<td>Mean: 1.18, Min: -0.48, Max: 3.64, SD: 0.76</td>
<td>+</td>
</tr>
<tr>
<td>ACR</td>
<td>Percentage of achievement under KCC scheme</td>
<td>Mean: 3.82, Min: 3.27, Max: 4.39, SD: 0.24</td>
<td>+</td>
</tr>
<tr>
<td>FRT</td>
<td>Fertiliser consumption in kg per hectare of total cropped area</td>
<td>Mean: 4.05, Min: 3.15, Max: 4.75, SD: 0.38</td>
<td>+</td>
</tr>
<tr>
<td>HYV</td>
<td>Percentage of area under HYV to net sown area</td>
<td>Mean: 4.15, Min: 3.07, Max: 4.72, SD: 0.40</td>
<td>+</td>
</tr>
</tbody>
</table>

### V. RESULTS AND DISCUSSIONS:

The result of the Regression analysis is presented in the following table:
Table 3: Results of the Regression Analysis:

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Variables</th>
<th>coefficients</th>
<th>Std.error</th>
<th>t- value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td>-1.207</td>
<td>8.507</td>
<td>-0.142</td>
<td>0.889</td>
</tr>
<tr>
<td>2</td>
<td>IRR</td>
<td>1.102</td>
<td>0.916</td>
<td>1.202</td>
<td>0.247</td>
</tr>
<tr>
<td>3</td>
<td>ROD</td>
<td>1.538</td>
<td>0.782</td>
<td>1.967</td>
<td>0.067*</td>
</tr>
<tr>
<td>4</td>
<td>ECT</td>
<td>-0.338</td>
<td>0.956</td>
<td>-0.353</td>
<td>0.729</td>
</tr>
<tr>
<td>5</td>
<td>EDN</td>
<td>-0.138</td>
<td>0.775</td>
<td>-0.178</td>
<td>0.861</td>
</tr>
<tr>
<td>6</td>
<td>HLT</td>
<td>-0.575</td>
<td>0.806</td>
<td>-0.714</td>
<td>0.486</td>
</tr>
<tr>
<td>7</td>
<td>BNK</td>
<td>0.905</td>
<td>0.398</td>
<td>2.273</td>
<td>0.037**</td>
</tr>
<tr>
<td>8</td>
<td>ACR</td>
<td>-0.914</td>
<td>0.931</td>
<td>-0.982</td>
<td>0.341</td>
</tr>
<tr>
<td>9</td>
<td>FRT</td>
<td>-0.018</td>
<td>0.638</td>
<td>-0.029</td>
<td>0.978</td>
</tr>
<tr>
<td>10</td>
<td>HYV</td>
<td>1.048</td>
<td>0.577</td>
<td>1.816</td>
<td>0.088*</td>
</tr>
</tbody>
</table>

| R²    | 0.531     |
| F     | 2.016     | 0.102*     |

Note: (***) indicate significant at 5% level.
(*) indicate significant at 10 % level.

The study mainly attempts to measure the impact of rural infrastructure taking into account the economic, social and institutional infrastructure on agricultural land productivity in 26 different districts of Assam using a simple OLS regression model for the period 2016. Summary statistics of the model representing Mean, Standard Deviation, Minimum and Maximum is presented in table 2. The above model 2 is estimated in linear logarithm form and results are presented in table 3. The sign of estimated coefficients are accorded to prior expectations of the model.

As per the results shown in the above table 3, it is found that among the seven infrastructure indicators along with two other variables only three indicators shows a positive and significant impact on agricultural land productivity namely the road infrastructure, banking and HYV. The results indicates that the estimate coefficient of the availability of road infrastructure is statistically significant at 10% level, for the ‘p’ value is 0.0627 (0.05<p≤ 0.10) and the ‘t’ value is 1.967 thus accepting the alternative hypothesis H₁:β₂ ≠ 0. The interpretation is that the ROD elasticity is (1.538) suggesting that, holding other variables constant, a 1 unit increase in the availability of ROD infrastructure in rural areas is associated with an increase of around 1.538 units in agricultural land productivity depicting a positive relationship between the road infrastructure and the land productivity. The institutional infrastructure representing the number of bank branches per 100 sq km of geographical area is positive and statistically significant at 5% level. Again, HYV area (%) being used as other variable is an important indicator of agricultural infrastructure shows a positive sign and is statistically significant at 10% level of significance. The other variables like irrigation, electricity, education, health, agricultural credit and fertiliser consumption are not significant in the model. To determine the overall fit of the model, it is found that R² (0.531) which is not so good fit for the model. The overall R² of 53 % shows that the model is moderate and 53 % of variations on the actual land productivity are captured by the estimated model. Similarly, the regression output of the overall significance of the parameters here found that the F statistics is (2.016) and is significant at 10 % level i.e.

Let H₀: all estimated coefficients are equal to zero.
H₁: all estimated coefficients are not equal to zero

F statistics is (2.016) and is significant at 10% level so we have to accept the alternative hypothesis. The level of significance is 0.102.

VI. CONCLUSION

Agricultural sector being the most prominent source of livelihood in Assam’s economy, the present study emphasised the importance of the infrastructural development across the different districts of Assam. After a detailed analysis of the impact of rural infrastructures on agricultural land productivity we can conclude that the estimations of the OLS model showed the importance of the rural infrastructures in boosting the agricultural productivity. Among the various number of rural infrastructures that has been undertaken in the study, the road transportation i.e, the total road length per 100 sq km of geographical area turned out to be significant at 10 % level respectively. Also, the number of banks under the institutional infrastructure proved to be significant and positive at 5 % level. Among the other variables, HYV turned out to be significant at 10% level. Thus, the foregoing analysis of the study reaches the validity of the research question that the rural infrastructure...
development influences the agricultural productivity significantly and among all the various type of infrastructures only the road, bank and HYV proved to have the significant impact on agricultural productivity. Along with the infrastructures, the other use of traditional inputs such as fertiliser application rainfall and climatic conditions are also responsible for significant results in land productivity across the district which has not been undertaken in the study. Thus, rural infrastructure significantly impacts the land productivity directly or indirectly through improvements in infrastructure facilities. Also, the study provides evidence in support of greater investment in infrastructure in rural areas and also at the same time important steps are to be taken to enlarge and maximise the utilisation of the resources in the respective state.

REFERENCES:


REPORTS:

[4]. Ministry of Agriculture and farmers welfare, Department of Agriculture, Cooperation And Farmers welfare, Directorate of Economics and Statistics, 2016, Govt of India.
[6]. Ministry of Power, 2017, Govt of India. [Village electrification data from CEA website].
[7]. Ministry of Statistics and Programme Implementation, Govt of India, Education Statistical Year of India, 2016.