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An Analysis on Agriculture Infrastructure and its impact on Agricultural Output in India

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Abstract

The aim of the present paper is to analyse the short run and long relationship of agricultural production with respect to agricultural infrastructure. For this purposes the cointegration of infrastructure and agricultural output was carried out using ARDL model. The model shows that there is significant link between infrastructure and agricultural output. Irrigation, electricity and fertilizer consumption plays a vital role in in scripting the spectacular success story of agriculture. Access to electricity creates various income earning opportunities for rural households. The analysis shows that the infrastructure plays significant role in improving the agricultural productivity, inadequate infrastructure can be big constraint to growth and productivity. The infrastructure influences the agricultural growth, economic growth. The study suggested that for remarkable progress in agriculture field, there is need to increase irrigated area, electricity consumption, which is possible only by improving the share of public investment on agriculture like massive investment in irrigation, better management of canal irrigation, massive expansion in the supply of electric pumps, assured quality electricity to agriculture and subsidised farm implements and assets and also transparency in accessing majority of schemes have been drivers of agricultural growth. Government spending on production related aspects likewise irrigation, electricity, roads etc. will contribute to reduction in rural poverty and agriculture growth. The present study is unique in the sense that while most of the previous studies have focused on static relationship between output and infrastructure, this study focus on dynamic relationship between output and infrastructure.

Keywords: Rural infrastructure, Agriculture, Cointegration, Spectacular, Investment

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Introduction

Agriculture is the basic activity by which humans live and survive on the earth. Agriculture is backbone and engine of Indian economy. It plays vital role in the development of Indian economy, particularly in rural economy. Nearly more than 60 percent of population are engaged in agricultural pursuits especially in rural areas, it is not only considered as an occupation carried out by farmers but still depend on agriculture for their subsistence and as an important aspect to shape the way of life and the pattern of their living and also most of industries also depend upon agriculture for their raw material. However, the share of agriculture sector to GDP continues to decline since economic planning begins in India this is because of inadequate infrastructural facilities.

Agriculture is specifically linked to many facets of sustainable development, likewise poverty reduction, sustainable utilization and production, administration of natural resources, technological transfer and capacity building as well as trade and market access. Agribusiness will be essential analytics and general advancement system, serving towards it. For achieving the inclusive growth, it is essential to reduce disparity likewise social inequality, regional disparities etc. Infrastructure plays significant role in improving the agricultural productivity, inadequate infrastructure can be big constraint to growth and productivity. Improving agricultural productivity reduces the food prices, benefits both urban and rural inhabitants who are net food buyers and hence has significant poverty-reduction effects.

Agricultural infrastructures are broadly classified into: i) capital intensive- irrigation, bridges; ii) institutional- formal and informal institutions, thus determining the nature and magnitude of agriculture development in India. Competent infrastructure improves agricultural productivity and lowers farming costs and thus accelerates agricultural as well as economic growth rate. Rural infrastructure is crucial significantly for improving the standard of life and for accelerating the process of agricultural development. Rural infrastructure has direct linkage with farmers, access to market and institutional finance, increasing crop yields and thereby promoting agriculture growth. Agricultural infrastructure has the potential to transform the existing traditional agriculture or subsistence farming into a most modern, commercial and dynamic farming system in India. The influence of infrastructure for the

improvement of agriculture has been broadly distinguished in most developing countries. Advancement of infrastructure may be pivotal particularly in rural areas as they have implications for productivity gains and poverty reduction (**Fan** & **Thorat 1999**; **Hazell** & **Haddad 2001**). In spite of climatic conditions, government support mechanism, technology improvements, strategy decisions, international trade, etc. can encourage better productivity; it does not decrease the vitality of provisions of sufficient and proper infrastructural facilities at the ground level.

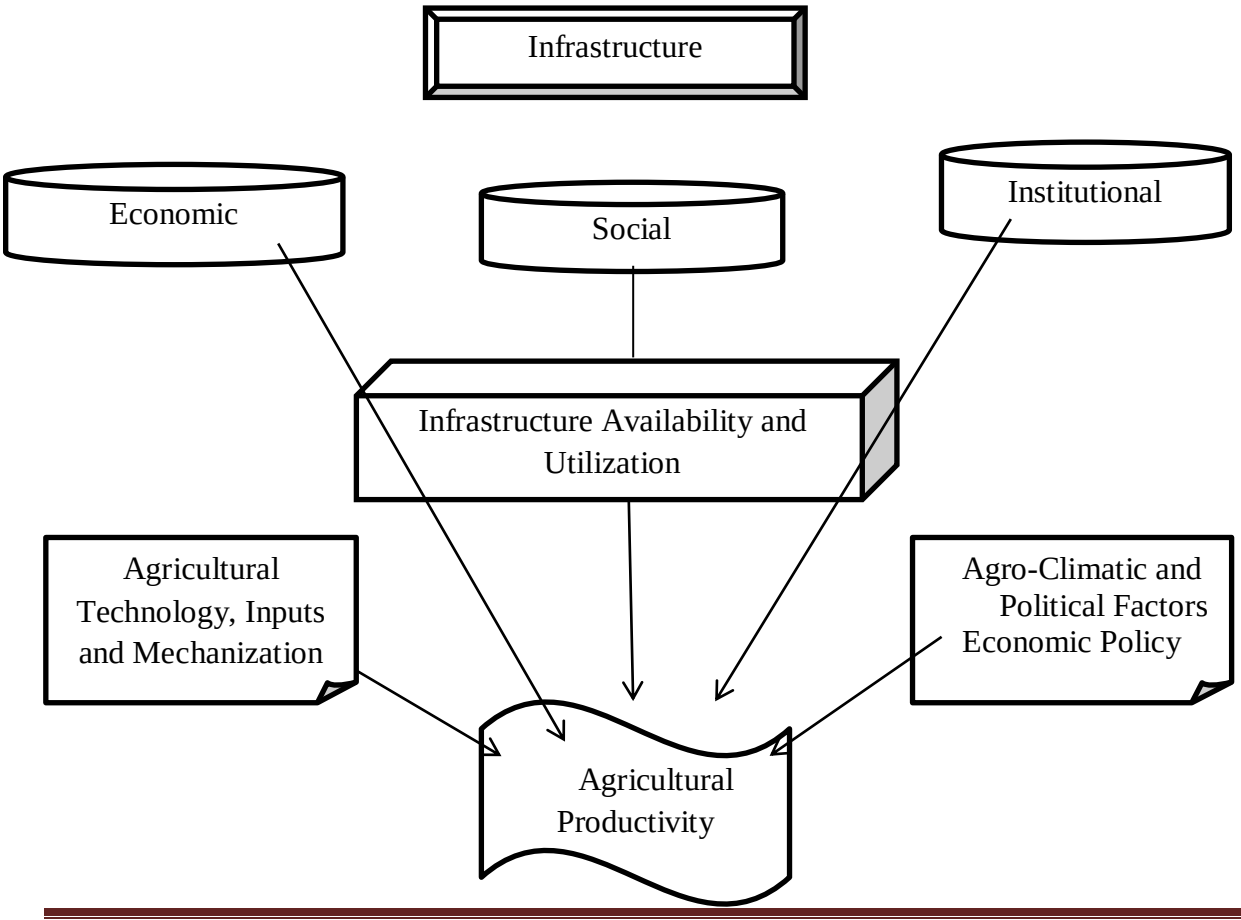
The requirement to attain the adjusted regional development has been one of the standout challenges for India's policy planners. Inequality in nature of developmental techniques might be because of the fact that few growing sectors dominate the progress of the economy, adding to the continuum of rural-urban contrasts. In this regard, agriculture sector which accepts essential importance in rural areas, has been performing moderately poorer contrasted to other sectors. Its declining commitment with GDP share, regardless of more than half of rural population constantly involved in this sector is an affirmation of the generally poor performance. Agriculture development as an approach to minimize regional disparities proceeds to assume prominence even today. The Indian economy presents a good case to examine the relationship between agricultural development and rural infrastructure as its production performance has been quite varying (**Chand et. al, 2009**; **Kannan and Shah, 2010**). With extensive dry regions and some drought-prone regions, the development of the Indian economy unbalanced. The vast extent of dry, unirrigated land casts its long shadow on the socio-economic development of the rural people in many significant ways. The inequality in agriculture performance and existence of regional variations are often attributed to disparities in natural resources endownments and also socio-economic and institutional factors (**Deshpande, 2006**). Provided the importance of infrastructure as an approach for agriculture development, it is imperative to inspect the pathways in which focused infrastructure can help to alleviate the regional disparities. Also, the deficient resources need to be mobilized to get the expected outcome and improve development of this primary sector.

Agricultural productivity can be increased through specific investments in infrastructure. The place of infrastructure in agricultural development was empirically examined using farm level data and found that rural infrastructure index has the highest positive impact on agricultural productivity (**Segun 2008**). Access to electricity and paved

roads has a positive and significant influence on agricultural productivity while irrigation had a positive but insignificant relationship with agricultural productivity (**Llanto, 2012**). **Ashok and Balasubramanian (2009**) found that irrigation, roads, markets and literacy has positive influence on agricultural development by employing total factor productivity approach. The dispersion in social, economic and general infrastructure was examined using modified Cobb-Douglas production function and adopted Biehl's methodology to measure the infrastructure index and underlined the importance of social infrastructure in achieving/ hindering inclusive growth.

Agriculture development is a multi-dimensional phenomenon where different factors and conditions should work together to achieve the potential level of output. Infrastructure is categorized as: Economic infrastructure, Social infrastructure and Institutional infrastructure. These infrastructures determine either directly or indirectly the development of agriculture. Agriculture development is influenced by different factors: development of rural infrastructure, technological improvements, agro-climatic conditions and economics policies.

Conceptual framework



Fig; Author's compilation

From the above brief outline of research studies, it is clear that the availability of infrastructure and its linkage with agricultural production plays a crucial role in agricultural development. The mere creation of infrastructure will not affect improvements in agricultural productivity, the utilisation of infrastructure stocks is compulsory to attain the goals of development. The present study examines the linkages between infrastructure and agricultural production in Indian economy. The study tried to analyse how different types of infrastructure affected agricultural production from last few years. Along with infrastructure, other agricultural inputs and variables which are pillars of agricultural development have also been analysed in this article.

List of Variables

S.No	Type of Infrastructure/Agricultural Inputs	Indicators	Variables
1.	Economic Infrastructure	Irrigation	Net irrigated area
		Transport	Road length
		Electricity	Electricity Consumption
2.	Agricultural Inputs	Input	Fertilizer Consumption
		Machinery	No. of Tractors and Power Tillers

Author's compilation

Research Methodology

Data has been collected and compiled from various secondary sources. Most of the data was collected from different rounds of agricultural statistics, Department of Agriculture, Cooperation and Farmers Welfare; Indian Council of Agricultural Research (ICAR), Ministry of Road Transport and High-ways, Government of India; Ministry of Agriculture and Farmers Welfare, Govt. of India; Central Electricity Authority, New Delhi, pertains to the period 2004-05 to 2013-14. Agricultural development depends on various indicators such as irrigation, electricity, transports and also some other important agricultural inputs like fertilizer consumption, no. of tractors and tillers etc.

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Thus, in order to estimate the relationship between agricultural development and infrastructure, the Auto-regression distributed lag model was applied. The autoregressive distributed lag (ARDL) 1 model is being used for decades to model the relationship between (economic) variables in a single-equation time-series setup. Its popularity also stems from the fact that cointegration of nonstationary variables is equivalent to an error-correction (EC) process, and the ARDL model has a reparameterization in EC form (**Engle and Granger, 1987; Hassler and Wolters, 2006**). The existence of a long-run / cointegration relationship can be tested based on the EC representation. A distributed-lag model is a dynamic model in which the effect of a regressor *x* on *y* occurs over time rather than all at once. The agricultural production was regressed on different explanatory variables. The following equation was used:

Auto- Regression Distributed Lag (ARDL) Equation:

$$\Delta \mathrm{LPROD}_{2_t} = \alpha_0 + \sum_{i=1}^{p} \alpha_{2i}\, \Delta \mathrm{LPROD}_{2_{t-i}} + \sum_{i=0}^{p} \alpha_{2i} \Delta \mathrm{LFLT}_{t-i} + \sum_{i=0}^{p} \alpha_{3i} \Delta \mathrm{LELE}_{t-i} + \sum_{i=0}^{p} \alpha_{4i} \Delta \mathrm{LIRG}_{t-i} + \alpha_5 \mathrm{LPROD}_{2_{t-i}} + \alpha_6 \mathrm{LFLT}_{2_{t-i}} + \alpha_7 \mathrm{LELE}_{2_{t-i}} + \alpha_8 \mathrm{LIRG}_{2_{t-i}} + \varepsilon_{1t} \quad \textbf{(1)}$$

The joint F-test of the lagged level variables in the equations (1) is used to test the presence of long run equilibrium relationship, **Pesaran and Shin (2007**). For example in equation (1) the test for the difference is carried out by testing the null hypotheses of no cointegration is defined by H_0: $\alpha_5 = \alpha_6 = \alpha_7 = \alpha_8 = 0$, using the F test. The variables are said to be cointegrated otherwise the variables are not cointegrated. Similarly, procedures can also be carried out for testing the long run equilibrium relationships for equation (1).

The asymptotic distribution of the F statistics is non-standard under null hypothesis and it was originally derived and tabulated by Pesaran, Shin and Smith (2007). Two sets of critical values are provided, one which is appropriate where all the variables are I (1**) Pesaran, Shin and Smith (2007**), if the calculated F statistics falls above the upper critical values. a conclusive inference can be made regarding cointegration without knowing, whether the series are I (0) or I (1). In this case the variables are said to be cointegrated indicates existence of long run relationship among the variables. Alternatively if the calculated F-statistics falls below the lower critical vale the null hypothesis of no cointegration will not be rejected regardless whether the series are I (0) or I (1). In contrast

the interference is inconclusive if the calculated F-statistics falls within lower and upper critical values unless we know whether the series are I (0) or I (1) **Sharif (2012**).

Table 1 All India different indicators of Infrastructure

Year	Agriculture Output	Fertilizer consumption (000 Tonnes)	Electricity Consumption for Agriculture Purpose (GWH)	Net irrigated Area
2004-05	486505.6	18398.3	88555	59229
2005-06	547089.9	20340.5	90292	60837
2006-07	630996	21651.0	99023	62744
2007-08	645812.8	22570.1	104182	63189
2008-09	579856	24909.3	107776	63638
2009-10	571120.1	26486.4	119492	61936
2010-11	662961.1	28122.2	126377	63657
2011-12	696719.7	27790.0	140960	65693
2012-13	674411.3	25536.2	147662	66103
2013-14	697528.6	24482.4	152744	68100

Source: Agricultural Statistics at a Glance 2016, Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Directorate of Economics and Statistics

RESULTS AND DISCUSSION

Infrastructure plays a significant role in improving the agricultural output. Adequate, proper and quality infrastructure are never substitutes to efficient macroeconomic and agriculture-specific policies and the effective implementation of such policies, inadequate infrastructure can be a significant constraint to economic growth and productivity. Infrastructure like other public investments, improves agriculture output, which in turn induces growth in rural areas, bringing about higher agricultural wages and opens new opportunities for non-farm labour. The rise in agriculture output, reduces food prices, benefits both urban and rural residents who are net buyers. Moreover, aside from the growth benefits, agriculture output as significant impact on poverty reduction and employment generation. Rural infrastructure like access to irrigation, fertilizer consumption, access to electricity etc. provides poor farmers vast opportunities to raise their agriculture output and thus creates various income earning opportunities for rural households.

Effects of infrastructure on agricultural output

ARDL results with dynamic regressor method

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(LPROD(-1))	-0.602563	0.198865	-3.030012	0.0563
LOG(LELC)	-1.196233	0.289345	-4.134283	0.0257
LOG(LFLT)	-0.713203	0.559037	-1.275771	0.2919
LOG(LFLT(-1))	1.629452	0.677494	2.405116	0.0954
LOG(LIRGT)	4.313439	0.677831	6.363587	0.0079
C	-3.362931	1.115664	-3.014285	0.0570

R-squared	0.918578	Mean dependent var	1.757939
Adjusted R-squared	0.782873	S.D. dependent var	0.006743
S.E. of regression	0.003142	Akaike info criterion	-8.453289
Sum squared resid	2.96E-05	Schwarz criterion	-8.321806
Log likelihood	44.03980	Hannan-Quinn criter.	-8.737029
F-statistic	6.768974	Durbin-Watson stat	2.738964
Prob(F-statistic)	0.073189		

The ARDL results show that fertilizer consumption had no significant relationship with agriculture output at lag 0 means that during the first half of reference period fertilizer had no impact on agricultural output, however during second half of reference period fertilizer had significant impact on agricultural output at 1 per cent level of significance. Moreover, the irrigation and electricity consumption had significant impact on agricultural output at 1 per cent significance level.

Long run cointegration of Production (Wald test results)

variables	f- statistics	t-statistics	probability
Constant	3.181		
LFLT	16.66	33.31	0.100
LElEC	-4.13	17.09	0.025
LIRG	6.36	40.49	0.000

The above table represents the long run cointegration results for the agricultural production, Fertilizer consumption, Irrigation and Electricity. The results show that there is significant and negative cointegration between agriculture Production and electricity consumption at 5% level of significance. It means that these two variables move together in long run. Similarly, the results show that irrigation facilities and agriculture production are significantly cointegrated in the long run. It means that both variables converge in the long run.

Short run causality results

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG (LFLT)	-0.713203	0.158041	-4.512775	0.0203
Coint Eq(-1)*	-1.602563	0.181021	-8.852895	0.0030*

It is most important to be noted that cointegration equation minus one, it must be negative value and significant. If this value is negative and significant then we will say that there is short run relationship. On the basis of probability we can say that either there is a relationship or not. The above table presents the results of vector error correction model which represents short run cointegration among production and fertilizer consumption. The table shows that there is significant cointegration among agriculture production and fertilizer consumption in short run. These results confirm our ARDL dynamic regressor method results which show that fertilizer consumption was significantly and negatively cointegrated with production at lag 1.

There is critical link between infrastructure and agriculture growth as indicated by causality tests. The rural infrastructure like irrigation, electricity, fertilizer consumption directly influences the agricultural output by providing the farmers with possible options for production, processing, consumption, marketing and distribution. The rural association and its sustainability with agriculture have been weakened because of the inadequate rural infrastructure. The agriculture development has strong correlation with infrastructure. The unequal distribution in infrastructure would result in regional imbalances affecting the welfare of people. The rural areas having improved infrastructure (access to irrigation, electricity) will experience higher agriculture growth while as those having inadequate infrastructure, experiences low agriculture growth. Rural households benefit from having access to electricity; irrigation and fertilizer consumption. The results indicate the importance of infrastructure in raising the agriculture output and thus standard of living especially in rural areas.

Thus it is clear that the adequate agricultural output is effective measure for economic growth and poverty reduction, which depends on agriculture infrastructure, inputs, efficient domestic markets, appropriate institutions, and access to technology (**Andersen and Shimokawa, 2007**). Inadequate infrastructure has been found major reason for low

agricultural output and thus for growth and poverty reduction as well. The ill-maintained infrastructure facilities like irrigation system, costly electricity, costly tractors and tillers, fertilizers, roads etc. leads to low agricultural output and thus low welfare in rural areas in comparison to this the adequate infrastructure, will reduce poverty through improved agriculture production, is an important factor determining the successful integration in the economy.

CONCLUSION AND SUGGESTIONS

Indian economy is primarily an agriculture based economy. Agriculture is the vital source of wealth in the country. However, as compared to other counties is having various issues relating agriculture because of that agriculture growth has weakened. The main issues were infrastructure like Irrigation, Electricity, Fertilizer Consumption, Roads, and Procurement etc. The infrastructure has played a pivotal role in scripting the spectacular success story of agriculture. From forgoing analysis by using ARDL model, the infrastructure development and agricultural development has been analysed during the period 2004-2013. The analysis shows that the infrastructure plays significant role in improving the agricultural productivity, inadequate infrastructure can be big constraint to growth and productivity. The infrastructure influences the agricultural growth, economic growth. The study suggested that for remarkable progress in agriculture field, there is need to increase irrigated area which is possible only by improving the share of public investment on agriculture like massive investment in irrigation, better management of canal irrigation, massive expansion in the supply of electric pumps, assured quality electricity to agriculture and subsidised farm implements and assets and also transparency in accessing majority of schemes have been drivers of agricultural growth.

Infrastructure being the important factor influencing the agriculture growth as well as economic growth, the government should pay special attention towards it. Raising the agricultural output is an essential component government development strategy, because most of the poverty is associated with rural areas. The government should invest on rural infrastructure facilities more particularly on irrigation, electricity and should provide good quality of fertilizers at affordable prices. The failure investment in rural infrastructure would be critical bottleneck for future agriculture and as well as economic growth and poverty alleviation especially in rural areas. Government spending on production related aspects

likewise irrigation, electricity, roads etc. will contribute to reduction in rural poverty and agriculture growth. Policies should stress on land reforms, input and output pricing, investments in irrigation, infrastructure and insurance, legislation for biodiversity, geographic appellation, varietal protection and farmer's rights. The policy makers should focus on sustained implementation of the policy reform program, which includes key elements of development of rural infrastructure. Development of agro-ecology-relevant technologies based on an understanding of local agriculture and resource management practices need to be supported and promoted. Chemicals and pesticides banned in developed countries should not be dumped into developing countries in the name of liberalization, globalization and industrialization.

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