AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Ind. Jn. of Agri. Econ.
Vol.61, No.3, July-Sept. 2006

Rural Infrastructure and Agricultural Growth: Interdependence and Variability in Indo-Gangetic Plains of India

Ranjit Kumar, N.P. Singh, R.P. Singh and A.K. Vasisht*

INTRODUCTION

Adequate infrastructure facilities are an essential pre-condition for the agricultural growth and accelerated economic development. High transaction costs arising from inadequate and inefficient infrastructure can prevent the economy from realising its full growth potential regardless of the progress on other fronts. Infrastructure facilities often referred to as social overheads, which help to sustain the growth in production and income generation in the rest of the economy rather than within the infrastructure enterprises. The link between infrastructure and development is not a once for all affair, but is a continuous and ongoing process. The progress in economic development has to be preceded, accompanied and followed by progress in infrastructure in order to fulfill the objectives of self-accelerating process of economic development.

In a developing country like India, the infrastructural facilities are generally weak and inadequate. Despairingly, the rural areas, where more than 70 per cent of the total population reside, are the most neglected as it lacks even the minimal infrastructure services. The dual economy models inspired by the work of W.A. Lewis (1954) typically feature a distinction between a stagnant, traditional rural sector and a dynamic modern manufacturing sector (Hayami and Ruttan, 1985). It is believed that productivity growth did not spread from the centre to peripheral rural regions because the periphery focused on the supply of primary products (Prebisch, 1984). These theories imply both low productivity growth and a lack of convergence in productivity growth between two regions. The direct linkages between infrastructure and agricultural development can easily be ascertained within a region. The experiences have shown that increase in the stock of infrastructure is associated with increase in output. The progress of agriculture achieved in some parts of the country can be attributed directly with the rural infrastructure, where technological push alone could hardly achieve similar success without interplay of other infrastructure attributes.

* Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi - 110 012.
The authors acknowledge the help rendered by Ritambhara Singh, Research Associate for processing requisite data.

The Indo-Gangetic Plains (IGP) region of India constitutes nearly 38 per cent of the net sown area but contributes more than 50 per cent of the total foodgrains production in India, thus contributing significantly to the nation's food security. Although, the region has been the centre of major productivity gains in crop yields as a result of adoption of green revolution technologies, the impact has not been uniform across the regions mainly due to the differences in policy environment of the state governments as well as biophysical and socio-economic factors. The agricultural productivities are far ahead in the north western region (Punjab, Haryana and Western Uttar Pradesh) as compared to the eastern region represented by eastern Uttar Pradesh, Bihar and West Bengal where technological deepening benefits are not evident to the same extent as in the north western IGP region. There exists a vast geographical dispersion of productivity and high degree of variability in infrastructural facilities in the Indo-Gangetic plain region of India. It is in this context, the paper attempts to diagnose the interdependence and variability of agricultural growth and infrastructural facilities in the Indo-Gangetic plain region of India. This will also provide the needed policy direction for the rural infrastructure development in different states of the country.

DATA AND METHODOLOGY

The present study is based on the secondary data collected from various secondary sources. Data related to different parameters of agricultural development and rural infrastructures have been collected from different reports of Centre for Monitoring Indian Economy (CMIE), statistical abstracts of five states (Bihar, Haryana, Punjab, Uttar Pradesh and West Bengal) constituting Indo-gangetic Plains, Annual Reports of Reserve Bank of India (RBI), etc. for the period of 1980-81 to 2003-04. The six infrastructure parameters were taken in the study, viz., road density, villages electrified, number of commercial bank branches, percentage gross irrigated area, number of regulated markets and capacity of warehouses. The net agricultural state domestic product (NASDP) per gross cropped area (GCA) (in Rs./ha) was considered as the proxy for agricultural development in the states.

The present study at first examines the stock and progress of different rural infrastructure variables in different states of the region followed by the distances among the states on account of it. The distance between population, say two states, is captured by making use of a statistic known as Mahalanobis D^2 Statistics (Rao, 1952). For two p-variate (six infrastructural parameters) populations, the distance between them can be defined as:

$$D_{ij}^2 = \sum_{r=1}^{p} (\mu_{ri} - \mu_{rj})' \, C_r^{-1} \, (\mu_{ri} - \mu_{rj})$$
$$= (\mu_i - \mu_j)' \, C^{-1} (\mu_i - \mu_j)$$

where, μ_{ri}, μ_{rj} are means of infrastructure variable r in states i and j and; C_r^{-1} represents inverse matrix of covariance between infrastructure variables. Distances are computed based on means, variances and covariances for each of the states based on *p* infrastructure variables.

To know the influence of different infrastructural parameters on the NASDP per GCA in the selected states, both linear and power type of functions were fitted, out of which the latter explained maximum variation and the coefficients of the explanatory variables were more consistent in sign and economic logic also. The estimated function was as:

$$NASDP_i = \alpha X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} e^{u_i}$$

where, NASDP = net agricultural state domestic product per GCA (Rs. lakhs/ha), X_1= road density (km/ '000km^2), X_2= percentage of villages electrified, X_3= number of bank branches per GCA, X_4= percentage gross irrigated area, X_5= capacity of warehouses (tones/ha), X_6= number of regulated markets per GCA and u_i = random error term.

Exponential Smoothing Model was used as the method for forecasting NASDP per GCA. It is a recursive method that implies exponentially decreasing weights as the observations get older. For the study, Holt's exponential smoothing also known as double exponential smoothing method was applied. This method is used when there is trend in time series data (Makridakis and Wright, 1998 and Billah *et al*., 2006). In this model, there are two smoothing constants α and β (with values between 0 and 1) and three equations:

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + b_{t-1}) \quad 0 < \alpha < 1$$

$$b_t = \beta(L_t - L_{t-1}) + (1-\beta) b_{t-1} \quad 0 < \beta < 1$$

$$F_t = L_t + b_t m$$

where,

L_t = Estimate of the series, NASDP per GCA at time 't-th' year
Y_t = Time in years (2005-2015) and,
b_t = Estimate of the slope of the series at time 't'.
F_t = Estimated value for future time period.

RESULTS AND DISCUSSION

The irrigated agro-eco-system is the mainstay of India's agricultural economy as most of the irrigated agriculture in the country is concentrated in the Indo-Gangetic Plains (IGP) which are blessed with plentiful natural resources that include deep productive alluvial soils, good quality surface and ground water and climatic features that permit input intensive multiple cropping. This region is dominated by the rice-

wheat cropping system, which has been the cradle of the ”Green Revolution”. Although the IGP have been a center of major productivity gains in crop yield as a result of technological changes dovetailed with the conductive policy (price) environment, the impact has not been uniform across the region. The gains in productivity were greater in the north western region (Punjab, Haryana and Western Uttar Pradesh) in contrast to the eastern region represented by eastern Uttar Pradesh, Bihar and West Bengal where the benefits are not evident to the same extent as in the north western IGP region. A well-developed infrastructure always ensures a road to the socio-economic development of any region. Being a region of a highly blessed agricultural diversity, studying its infrastructural development will throw new insights with various policy implications.

GROWTH PERFORMANCE OF STATES IN INDO-GANGETIC PLAINS

The overall Net Agricultural State Domestic Product (NASDP) per GCA at factor cost shows an increasing trend for Haryana, Uttar Pradesh and West Bengal (Figure 1). During the past two decades, Punjab and Bihar showed a declining trend in NASDP per ha. The growth rate of NASDP was negative and lowest in Bihar while Uttar Pradesh recorded a satisfactory growth rate in NASDP and West Bengal closely followed it. Ahluwalia (2000) observed an interesting feature of the performance in the 1990s. The popular characterisation of the so called BIMARU states (Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh) as a homogeneous group of poor performers, a grouping originally proposed in the context of observed commonalities in demographic behaviour, does not hold as far as economic performance is concerned. Bihar and Uttar Pradesh performed very poorly, growing much more slowly than the average, but the other two members of this group, Rajasthan and Madhya Pradesh have performed reasonably well.

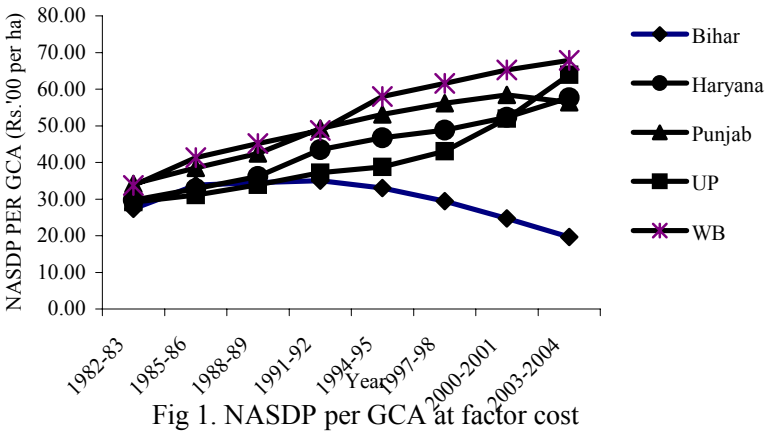

Fig 1. NASDP per GCA at factor cost (1980-81 prices) for selected states of IGP

As is evident from Table 1, the total capital expenditure per GCA was maximum in Uttar Pradesh followed by Haryana and Bihar. Punjab followed Bihar during TE 2003-04. The growth rate was the maximum for Haryana (19.46) followed by Uttar Pradesh (17.71) and Punjab (16.71). As far as the gross cropped area of different Indo-Gangetic states is concerned, it has decreased in 2003 as compared with 1980 in Bihar and Uttar Pradesh while in Haryana, Punjab and West Bengal, the area showed an increasing trend. The increase in the gross cropped area shows that the cropping intensity is also increasing in these areas.

TABLE 1. GROWTH IN CAPITAL EXPENDITURE, NASDP/HA AND GCA IN THE SELECTED STATES

(1)	Bihar (2)	Haryana (3)	Punjab (4)	Uttar Pradesh (5)	West Bengal (6)
Capital Expenditure per GCA (in Rs. '00 per hectare)					
TE 1990-91	4.94	3.11	3.28	3.95	3.55
TE 2003-04	14.30	18.21	14.12	27.26	11.27
Growth Rate (1990-2003)	11.99	19.46	16.71	17.71	11.34
NASDP per GCA (in Rs. '00 per hectare)					
TE 1982-83	27.30	29.68	34.16	29.21	33.67
TE 2003-04	19.65	57.64	56.43	63.97	67.86
Growth Rate (1980-2003)	-1.74	3.24	2.63	3.57	3.35
GCA (in '000 hectares)					
TE 1982-83	10472.67	5531.47	6869.00	24685.33	7345.17
TE 2003-04	9943.67	5936.00	9414.00	23268.33	9936.67
Growth Rate (1980-2003)	-0.29	0.52	1.31	-0.12	1.32

Development of Different Rural Infrastructures in IGP Region

In order to maintain the existing agricultural scenario of the region, a well-balanced infrastructure is a pre-requisite. The stock of important physical infrastructure like electric power generation, fertiliser production and irrigational facilities has expanded manifold in the country during 1950-51 to 1995-96. These infrastructure facilities significantly influenced production and growth in agriculture. Equally important is the marketing infrastructure including roads and transport, storage and market facilities which provide impetus to agricultural production growth through orderly disposal. While road lengths have increased seven times, the number of regulated markets in the country has increased from 206 to 6,836 during the same period (Bhatia, 1999).

The expansion in physical infrastructure requires large and continuous investment and hence its availability in different states depends upon the relative priority accorded by the state governments. The IGP has also witnessed improvement in the infrastructure facilities over time but vary significantly across the states. Table 2 presents the variation in basic infrastructural development in IGP region. Multitude of benefits are attributed to road development, including increased agricultural production, better farm prices, development of markets, growth of dairying, rural industrialisation, better educational standards, and higher life expectancy.

TABLE 2. GROWTH IN BASIC INFRASTRUCTURE IN THE SELECTED STATES

(1)	Bihar (2)	Haryana (3)	Punjab (4)	Uttar Pradesh (5)	West Bengal (6)
Road density (per '000 sq km of geographical area)					
TE 1982-83	504.74	380.13	866.03	316.19	642.33
TE 2003-04	524.07	686.46	1288.63	823.01	903.13
Growth Rate 1980-2003)	0.21	2.37	1.71	4.08	2.00
Villages electrified (per cent)					
TE 1982-83	37.38	96.32	94.77	42.74	39.25
TE 2003-04	63.57	96.72	97.13	63.50	73.16
Growth Rate 1980-2003)	2.20	0.02	0.11	1.74	3.17
Gross irrigated area (per cent					
TE 1982-83	33.85	72.52	87.08	49.20	19.79
TE 2003-04	58.57	87.00	95.16	67.26	37.06
Growth Rate (1980-2003)	2.45	0.73	0.44	1.99	2.85

Although road density has increased in all the states of the region during last two decades but it varies from 524 km/'000km^2 in Bihar to 1288 km/'000km^2 in Punjab in TE 2003-04. Growth rates of road density are also positive with the highest in Uttar Pradesh (4.08) followed by Haryana (2.37) and West Bengal (2.00). Increasing road density is a positive sign towards the economic development but the performance of Bihar is not satisfactory. The state therefore requires huge investment for the development of roads as it is directly related to poverty reduction strategies. Investment in roads reduces rural poverty through productivity growth, and also through increased non-agricultural employment opportunities and higher wages (Fan *et al.*, 2000).

Rural electrification is an important basic infrastructure as it leads to the adoption of several other better and advanced technologies in the region. Bihar and Uttar Pradesh in this regard still have a dubious distinction as still more than one-third of villages are not connected with electricity. The situation further aggravates if we consider the duration of electricity supply in the connected villages in these two states. As compared to TE 1982-83, per cent of villages electrified increased significantly in TE 2003-04 in Bihar, Uttar Pradesh and West Bengal, while rural population of Haryana and Punjab have for a long time maintained 100 per cent access to electrification.

As far as the irrigation infrastructure is concerned, the percentage of gross irrigated area is the highest (95.16 per cent) in Punjab followed by Haryana (87 per cent) and Uttar Pradesh (67.26 per cent). The states of Bihar and West Bengal stand last in terms of irrigational infrastructure development. Although, both the states have abundant surface water due to perennial rivers but irrigation network has not spread accordingly.

The data were also analysed with respect to other subsidiary infrastructure like coverage of bank branches, regulated markets and warehousing capacities in these states (Table 3). The number of bank branches per GCA indicates the easy availability of credit to the rural population and faster money circulation. It is surprising to note that the number of bank branches per GCA was the maximum in

Uttar Pradesh (0.42) and West Bengal (0.42) followed by Bihar (0.40), while in Punjab and Haryana, it was only 0.37 and 0.33, respectively.

TABLE 3. GROWTH IN SUBSIDIARY INFRASTRUCTURE IN SELECTED STATES

(1)	Bihar (2)	Haryana (3)	Punjab (4)	Uttar Pradesh (5)	West Bengal (6)
Bank branches per GCA (No./ha)					
TE 1982-83	0.26	0.19	0.33	0.23	0.35
TE 2003-04	0.40	0.33	0.37	0.42	0.42
Growth Rate (1980-2003)	2.09	2.17	0.69	2.23	0.73
Regulated markets per GCA (No./ha)					
TE 1982-83	0.05	0.03	0.07	0.03	0.04
TE 2003-04	0.08	0.05	0.07	0.03	0.06
Growth Rate (1980-2003)	1.73	1.36	-0.17	0.31	2.36
Capacity of warehouses per GCA (tonnes/ha)					
TE 1982-83	0.02	0.06	0.18	0.05	0.02
TE 2003-04	0.03	0.33	0.82	0.13	0.03
Growth Rate (1980-2003)	1.45	5.64	6.24	3.21	0.27

An efficient agricultural marketing system is essential for the development of the agricultural sector. The ever increasing production, spread of latest technologies, changing socio-economic environment, increasing demand for downsizing the distribution chain and reducing the margin between farmers and ultimate consumers and challenges emerging out of liberalisation require a vibrant, dynamic and assimilative marketing structure and system. With a view to cope up with the need to handle increasing agricultural production, the number of regulated markets has also been increasing in the country. While by the end of 1950, there were 286 regulated markets in the country, today this number stands at 7161. In the light of these facts Table 3 shows that the number of regulated markets per GCA has almost remained constant in almost all the states. Although, it appears to be confusing, but there has been structural changes in the existing regulated markets.

Agriculturally developed states say, Haryana and Punjab, took major steps to increase the handling capacity of those markets, provided state of the art facilities in the market, while left out states remained short-visioned and didn't put serious thinking about it. This is justified by the fact that there has been impressive growth in the capacities of warehouses in Punjab and Haryana. As the market expands structurally, the requirement of larger storage capacity arises. This expanding requirement got fillip from the government initiatives as the storage capacities have increased from 0.06 tonnes/ha to 0.33 tonnes/ha in Haryana and from 0.18 tonnes/ha to 0.82 tonnes/ha in Punjab during TE 1982-83 to TE 2003-04. Contrary to it, in Bihar and West Bengal, there have not been much changes, while Uttar Pradesh has shown some sort of resilience.

Distance/Disparity Among States in Terms of Infrastructure Perspectives

There seemed to be wide disparities in infrastructural facilities over different states included in the study thereby, affecting the economy of the backward states.

The seven indices used in the study, i.e., NASDP per GCA, road density, electricity, bank branches, per cent of gross irrigated area, warehouses, and regulated markets were subjected to statistical analysis using Mahalanobis D-square statistics. It represented the distance between mean values in a discriminant function and provided the maximum differences between any two states with respect to the differences in their mean values. D-square values for each of $^5C_2$ (ten) pair of states were calculated and tested for their statistical significance (Table 4). Lower values of D^2 represented smaller differences thereby indicating similarity among respective states being compared. A non-significant D^2 indicated that there were no significant differences among the states with respect to the seven indices involved. These seven factors jointly registered significant D^2 values indicating disparities on these accounts in the areas studied.

TABLE 4. MAHALANOBIS D^2 STATISTIC MATRIX FOR SELECTED STATES BASED ON RURAL INFRASTRUCTURE

(1)	Bihar (2)	Haryana (3)	Punjab (4)	Uttar Pradesh (5)
Haryana	17.5680*** (43.920)			
Punjab	15.9880*** (39.970)	7.3382*** (18.345)		
Uttar Pradesh	10.9196*** (27.299)	7.4869*** (18.717)	14.8822*** (37.206)	
West Bengal	3.7504** (9.376)	20.8713*** (52.178)	23.0732*** (57.683)	9.0431*** (22.608)

*** and ** indicate the D^2 statistic are significant at 1 per cent and 5 per cent level of probability, respectively. Figures parentheses are the F-value for d.f. (6, 5). Note: Tabular values of F (6, 5) are 10.7 and 4.95 at 1 and 5 per cent of probability, respectively.

The table reveals that the states of Bihar and West Bengal registered very little distance (though significant) between themselves in comparison to all other paired comparisons among the five states under study, meaning thereby larger similarity as far as these infrastructural parameters are concerned. On the other hand, the value of D^2 statistic between the states of Punjab and Haryana and Uttar Pradesh and Haryana was of the order of 7, showing a similar level of similarity among these seven indices but it was found to be significant. In all other paired comparisons among the states under study there were large level of dis-similarities. The test statistic revealed that although there were significant differences among the states with respect to the seven indices involved, the magnitude of differences were found to be the least between the states of Bihar and West Bengal followed by Punjab-Haryana and Uttar Pradesh-Haryana in that order. The imbalances among these states need to be corrected with utmost priority in any future planning of agro-economic development activities.

Factors Influencing the Agricultural Development in the IGP Region

For determining the factors affecting NASDP, the estimated Cobb-Douglas functional relationship with NASDP per GCA of different states and infrastructure parameters is given in Table 5. A perusal of the table revealed that road density (X_1) was found to have non-significant impact on NASDP per GCA of all the states except West Bengal where the relationship was significant and positive while in Bihar, it has negative and significant influence. As expected, village electrification (X_2) showed significant and positive influence on NASDP per GCA only in Haryana and Punjab. The number of bank branches per GCA (X_3) had no significant relationship with NASDP in any of the states.

TABLE 5. FACTORS AFFECTING NASDP PER GCA OF DIFFERENT STATES OF INDO-GANGETIC PLAINS, 1980-81 TO 2003-04

Parameters (1)	Bihar (2)	Haryana (3)	Punjab (4)	Uttar Pradesh (5)	West Bengal (6)
Road density (km/'000 km^2)	-0.74**	-0.03	0.01	0.06	0.47*
	(0.32)	(0.104)	(0.144)	(0.035)	(0.24)
Villages electrified (per cent)	0.22	64.64**	8.35**	0.90	-0.03
	(0.15)	(23.28)	(3.28)	(0.76)	(0.21)
Bank branches (No./ha)	0.41	1.15	0.56	-0.84	0.15
	(0.27)	(0.83)	(0.34)	(0.65)	(0.10)
Gross irrigated area (per cent)	-1.18***	-0.03	1.60***	0.70***	0.34**
	(0.13)	(0.46)	(0.56)	(0.16)	(0.15)
Capacity of warehouses (t/ha)	-0.09*	0.11	0.07	0.49***	0.50*
	(0.18)	(0.11)	(0.07)	(0.14)	(0.26)
Regulated markets (No./ha)	0.05	-0.93	-0.06	1.77**	0.53*
	(0.12)	(0.63)	(0.09)	(0.86)	(0.27)
Intercept	11.63	-292.60	-41.10	3.56	2.84
Adjusted R^2	0.89	0.87	0.94	0.96	0.93

***, ** and * Significant at 1, 5 and 10 per cent of probabilities, respectively.

Irrigation infrastructure has significant influence on the state agricultural domestic product. While the variable, irrigated area (X_4) negatively influenced the NASDP per GCA of Bihar for the reasons explained earlier, the coefficients were found to be positive and significant in case of Punjab, Uttar Pradesh and West Bengal. The coefficients for capacities of warehouses per GCA (X_5) were negative and significant in Bihar while they were positive and significant in Uttar Pradesh and West Bengal states. The variable did not show any significant impact on the NASDP of Haryana and Punjab. It may be due to the fact that the capacity of warehouses even in these states are far less than the NASDP, and the farmers as well as Government procurement agencies resort to storing the foodgrains on the roadside under temporary shades. Similarly, the number of regulated markets per GCA (X_6) has positive and significant impact on NASDP only in Uttar Pradesh and West Bengal.

Overall, the results showed that the infrastructural variables under study had significant impact on the agricultural growth and development in one or the other states. The variables like bank branches and number of regulated markets could not show their influence in the regression because of mis-specification of the variables as the impact of these kind of infrastructures are more visible when the volume of the business handled by them are considered.

Forecasting of State Agricultural Domestic Product in the Region

The value of NASDP per GCA was forecast using exponential smoothening models for the period 2005 – 2015 (Appendix I). Figure 2 reveals that if the policy environment and Government priorities do not get changed in the near future, the projected value of NASDP per GCA in Bihar has very dismal future. The projected NASDP per GCA may fall to Rs. 33/ha in the year 2015 from Rs. 1644/ha in 2005 in Bihar. The trend of NASDP for Punjab state is also not very much encouraging as it has a falling trend in the long run. This may be attributed to the fast declining total factor productivity (TFP) growth in the trans-gangetic plains, i.e., Punjab state, while in the middle gangetic plain, i.e., in Bihar state, TFP growth has stagnated (Kumar *et al.,* 2002). The soils in some districts of Punjab are salt affected. This region has already experienced a number of second generation problems, like increased incidence of insect pests, problem of weeds, etc., which induced the indiscriminate use of pesticides and herbicides. The indiscriminate groundwater utilisation and declining biodiversity has severely affected the total factor productivity in these regions. The groundwater utilisation has been excessively increasing without any provision of recharge. The over utilisation of ground water has caused steep fall in water table, which in turn has escalated the water cost.

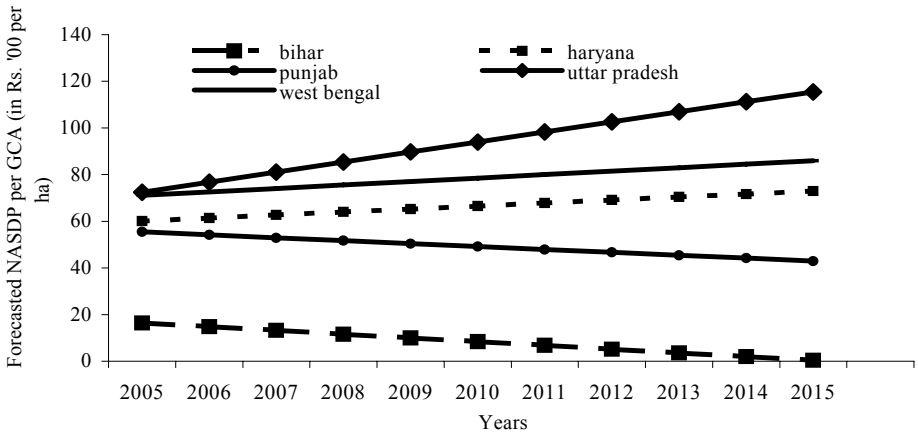

Figure 2. Projected NASDP Per GCA for the States of Indo-Gangetic Plains.

On the other hand West Bengal, which was earlier characterised as a mono-crop area due to extensive rice cultivation, has now embraced crop diversification leading to high growth in agricultural development. The output growth in the West Bengal has accrued essentially from the better utilisation of the existing infrastructure, stepping up the use of modern inputs and extension of green revolution to the new areas of West Bengal. The NASDP per GCA in West Bengal is expected to increase from Rs. 7,107/ha in 2005 to Rs. 8,592/ha by 2015. The most surprising result have been observed in the case of Uttar Pradesh, which is expected to show very robust future growth. This may be due to recent spurt in agricultural growth in the states due to concerted effort towards crop diversification and value addition.

CONCLUSIONS AND POLICY IMPLICATIONS

Regional differences in per capita income levels have long been a matter of concern in India and for good reason. The per capita gross state domestic product (GSDP) of Punjab, the richest state at one end of the spectrum, is five times that of Bihar, at the other end of the spectrum. Balanced regional development has always been stated as an objective in India's plans, but concerted efforts with conviction have been lacking with the concerned central/state governments. The study has established strong relationship between rural infrastructural development and level of net state agricultural domestic product (NSADP). There is significant scope for increasing the value of output from agriculture in erstwhile backward states by improving the rural infrastructure. The interdependence and variability in rural infrastructural development in these states of the region is bound to yield divergent economic development as is evident from the diverging current as well as projected NASDP per GCA. Several studies dealt with long term trends concluded that there is no evidence of unconditional convergence but there is evidence of conditional convergence. In other words, the long-term time paths of NASDP per GCA across states would show convergence if adequate steps in terms of capital infusion in rural infrastructure development are taken.

Two important policy implications emerged from the study: firstly; there is need to reduce the disparities in terms of ever-increasing divergence in per capita NASDP among these states to have balanced growth in the region, and secondly; the factors like road density, rural electrification, irrigation network and marketing infrastructure emerged as significant factors influencing the agricultural development in these states. These factors need to be strengthened in the states of Bihar, West Bengal and Uttar Pradesh to arrest the slowdown in economic development of the states.

Since, the public sector has not been able to make the investment to the desired level in the backward states, the private sector should be encouraged to enter into this venture. However, private investors alone would tend to shun the rural areas, because of low expected rates of return. The priority allocation of resources in the development of these rural infrastructures through public-private partnership would

yield enormous returns in the long-term perspective. Therefore, the public-private partnership is necessary where subsidies or incentives provided by the government would help to attract private investment towards the disadvantaged areas.

REFERENCES

Ahluwalia, M. S. (2000), "State Level Performance under Economic Reforms in India", Paper presented at the Centre for Research on Economic Development and Policy Reform Conference on Indian Economic Prospects: Advancing Policy Reform, May 2000; Stanford University.

Bhatia, M.S. (1999), "Rural Infrastructure and Growth in Agriculture", *Economic and Political Weekly Review of Agriculture,* Special Article, Vol.34, No.13, March 27-April 2 pp.A-43-A-48.

Billah, Baki; Maxwell L. King; Ralph D. Snyder and Anne B. Koehler (2006), "Exponential Smoothing Model Selection for Forecasting", *International Journal of Forecasting*, Vol. 22, pp. 239-247.

Fan, Shenggen, Peter hazel and S.K. Thorat (2000), "Impact of Public Expenditure on Poverty in rural India", *Economic and Political Weekly*, Vol 35, No 40, September 30, pp.3581-3588.

Hayami, Y. and V.W. Ruttan (1985), *Agricultural Development: An International Perspective*, The John Hopkins University Press, Baltimore.

Kumar, P., D. Jha, A. Kumar, M.K. Chaudhary, R.K. Grover, R.K. Singh, R.K.P. Singh, A. Mitra, P.K. Joshi, A. Singh and P.S. Badal (2002), *Economic Analysis of Total Factor Productivity of Crop Sector in the Indo-Gangetic Plain of India by District and Region,* NATP Project Report, Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi.

Lewis, W.A. (1954), "Economic Development with Unlimited Supplies of Labour", *Manchester School,* pp. 130-190.

Makridakis and Wheel Wright (1998), *Exponential Smoothing Methods, Forecasting Methods and Applications,* John Wiley and Sons, New York, pp. 133-180.

Prebisch, R. (1984), "Five Stages in My Thinking about Economic Development", in G. Meier, and D. Seers (Eds.) (1984), *Pioneers in Development*, Oxford University Press for the World Bank.

Rao, C.R. (1952), *Advanced Statistical Methods in Biometric Research*, John Wiley and Sons Inc., New York.

APPENDIX

PROJECTED VALUES OF NASDP PER GCA IN STATES OF INDO- GANGETIC PLAINS IN INDIA

(Rs. '00 per ha)

Year (1)	Bihar (2)	Haryana (3)	Punjab (4)	Uttar Pradesh (5)	West Bengal (6)
2005	16.44	60.13	55.44	72.46	71.07
2006	14.83	61.42	54.19	76.76	72.56
2007	13.21	62.70	52.93	81.07	74.04
2008	11.61	63.94	51.68	85.37	75.53
2009	9.99	65.27	50.43	89.68	77.01
2010	8.38	66.55	49.17	93.99	78.50
2011	6.77	67.84	47.92	98.30	79.98
2012	5.16	69.12	46.66	102.61	81.47
2013	3.55	70.40	45.41	106.91	82.95
2014	1.94	71.69	44.16	111.22	84.44
2015	0.33	72.97	42.91	115.53	85.92