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INTER-REGIONAL DISPARITIES IN AGRICULTURAL INFRASTRUCTURE—A CASE STUDY OF BIHAR*

Infrastructure plays an important role in agricultural development.[1] In fact, the farmers of a region with abundance of infrastructure may be in a better position to utilize their limited land resources than those of a region where the necessary infrastructure is lacking. The increasing role of infrastructure in agricultural development specially after the introduction of the High-Yielding Variety (HYV) technology in 1966 deserves special attention.

Bihar which is one of the most backward States in India is selected for the present study. A detailed analysis of the relative backwardness of Bihar among the States in India is already made by Prasad.[2] So far as the level of infrastructure is concerned, Bihar was placed ninth by Shah,[3] among the 16 States examined during 1966-67. Actually, Bihar itself exhibits intra-regional differences. The State has been divided into three natural regions, *viz.*, North Bihar Plain—north of the river Ganges, South Bihar Plain—south of the river Ganges and Chotanagpur Plateau—located in the extreme south and south-east of Bihar.

The paper examines the extent of inter-regional disparities in the agricultural infrastructure in Bihar. We have also gone into the details of the direct and indirect role of infrastructure in determining the level of agricultural productivity in Bihar with the help of cross-sectional data across the districts.

The study is based on the data available for the 31 districts of Bihar. Most of the information on districtwise infrastructural facilities and adoption of new agricultural practices was collected from the office of the Director, Department of Agriculture (Agricultural Statistics Section), Government of Bihar, Patna. Other supplementary data on infrastructure and data related to agricultural productivity are taken from Bihar Statistical Hand Book 1978 and Bihar Through Figures 1977, both published by the Directorate of Statistics and Evaluation, Government of Bihar, Patna. All these data refer to the year 1976-77 except in a few cases for which 1976-77 data are not available. It is needless to say that the validity of our conclusion is contingent upon the accuracy of these data.

REGIONAL DISPARITIES IN AGRICULTURAL INFRASTRUCTURE

In fact, it is very difficult to isolate the items of infrastructure, which are exclusively related to agriculture. However, we have taken care of it

*This is a revised version of the paper, "Infrastructure and Economic Performance—A Cross Section Analysis of Bihar", presented by the author at the 19th Indian Econometric Society Conference held at Poona during December 1980.

1. C. R. Wharton (Jr.), "The Infrastructure for Agricultural Growth," in Herman M. Southworth and Bruce F. Johnston (Eds.): Agricultural Development and Economic Growth, Cornell University Press, Ithaca, New York, 1967, pp. 107-142.

2. K. N. Prasad: The Economics of Backward Region in a Backward Economy: A Case Study of Bihar in relation to Other States of India (2 Vols.), Scientific Book Agency, Calcutta, 1967.

3. N. Shah, "Infrastructure for the Indian Economy", *Commerce*, Vol. 119, No. 3061, Annual Number, 1969.

to the extent possible, while selecting individual items of infrastructure though the ultimate selection is conditional on the availability of the districtwise information. Infrastructure in its broad sense, used in this study, covers the items which provide external economies to the farmers as a whole. As many as seven items of infrastructure are included in the present study, such as (1) Irrigation—The percentage of gross sown area irrigated in the district during 1976-77 is used as a proxy for the irrigational facilities made available to the farmers by the Government because Government canals, tubewells and other wells contribute more than 70 per cent of the total area irrigated in the State. (2) Finance—Availability of agricultural credit through various agencies per rural family during 1976-77. (3) Power—Percentage of inhabited villages electrified in the district as on March 31, 1975. (4) Marketing—Number of regulated markets per lakh households in the district as on October 29, 1975. (5) Education—Rural Literacy rate (in per cent) in the district as per 1971 Census. (6) Transport—Length of road (in km.) per thousand square km. area of the district as on March 31, 1975. And (7) Extension Services—Number of composite demonstrations conducted for paddy and wheat per lakh households in the district during 1976-77 is taken for this purpose. Regional figures relating to the above items of infrastructure are computed from the relevant district figures included in the regions and presented in Table I.

TABLE I—REGIONAL DISPARITIES IN INFRASTRUCTURAL FACILITIES IN BIHAR—SOME SELECTED ITEMS

Items	North Bihar Plain region	South Bihar Plain region	Chotanagpur region	Bihar State
1. Percentage of gross area sown irrigated during 1976-77	25·40	57·48	9·16	31·83
2. Availability of agricultural credit through various agencies* per rural family (in rupees) during 1976-77	45·24	65·79	23·43	46·27
3. Percentage of inhabited villages electrified as on March 31, 1975	20·12	44·74	7·33	21·66
4. Rural literacy rate as per 1971 Census	15·69	20·85	15·13	17·17
5. Number of regulated markets per block as on October 29, 1975	0·21	0·19	0·09	0·16
6. Road length**(in km.) per thousand square km. as on March 31, 1975 ..	796·14	476·84	390·79	540·80
7. Number of composite demonstrations*** for paddy and wheat per lakh of households during 1976-77	19·40	18·55	11·46	16·54

Sources: (*a*) Item 1 is computed from the data available in the office of the Directorate of Statistics and Evaluation, Government of Bihar, Patna.
(*b*) Items 2, 5 and 7 are prepared on the basis of information available at the office of the Director, Department of Agriculture, Government of Bihar, Patna.
(*c*) Items 3, 4 and 6 are computed from the actual values available in the Bihar Statistical Hand Book 1978 and Bihar Through Figures 1977, both published by the Directorate of Statistics and Evaluation, Government of Bihar, Patna.

Notes:— * Like government, co-operatives and commercial banks.
** It includes all *pucca* roads (including those of urban centres).
*** Composite demonstrations are conducted by the officials of the Department of Agriculture, Government of Bihar on farmer's plot showing the composite effect of using the new agricultural practices, mainly chemical fertilizers, HYV seeds and insecticides.

Table I indicates the extent of regional disparities in infrastructural facilities available in Bihar. The extent of irrigation has considerably increased after the introduction of new technology in agriculture but the Chotanagpur region is lacking in this basic input very much. The percentage of gross irrigated area to the gross sown area is only 9.2 during 1976-77 in the Chotanagpur region as against 25.4 per cent, 57.5 per cent and 31.8 per cent in the North Bihar Plain, the South Bihar Plain and the Bihar State respectively. Other infrastructural facilities which directly relate to the agricultural performance of a region are the availability of credit, power, education, transport and marketing facilities but these facilities are very poor in the Chotanagpur region as compared to the other regions of Bihar as shown in items 2, 3, 4, 5 and 6 in Table I. Chotanagpur farmers, because of their socio-economic backwardness, deserve special attention as regards the provision of extension services but it looks as if they are neglected in this regard (see item 7 in Table I).

INFRASTRUCTURE AND AGRICULTURAL PRODUCTIVITY

We have prepared the composite index of infrastructure and used it to measure the relative positions of the overall agricultural infrastructure in the districts. An index of infrastructure has been constructed as a simple index of weighted standard scores for individual infrastructural items, the correlation coefficients between agricultural productivity per hectare and individual items of infrastructure as weights.[4] Agricultural productivity used in this study is the gross value of agricultural output (of ten major crops grown in Bihar covering about 85 per cent of the gross sown area) per hectare during 1976-77 at constant (1961) prices. Regional differences in the composite index of infrastructure and agricultural productivity along with the differences in the level of adoption of new agricultural practices as measured by the adoption index[5] in the three regions are presented in Table II.

Table II reveals that the South Bihar Plain region is highly endowed with the infrastructural facilities, whereas these facilities are lacking very much in

4. Symbolically, one can put the weighted standard score as follows:

$$\left[Z_{wi} = \sum_{j=1}^{m} r_{oj} \, z_{ij} \Big/ \sum_{j=i}^{m} r_{oj} \; ; \; \begin{matrix} i = 1, 2, \ldots\ldots\ldots n \\ j = 1, 2, \ldots\ldots\ldots m \end{matrix} \right]$$

where, Z_{wi} = weighted standard scores of the ith district.

$z_{ij} = (x_{ij} - \bar{x}_{ij}) / s_{xij}$ = standard scores of jth item in ith district; $\bar{x}_{ij}$ and s_{xij} indicate mean and standard deviation respectively. r_{oj} = correlation coefficient between the agricultural productivity (cental value) and jth item of infrastructure. An index was then prepared with 2 added to it to avoid the negative sign and multiplied by fifty.

5. The following items of new agricultural practices are included in preparing the indices of adoption for the districts: (1) Use of HYV seeds—The proportion of the area covered under HYV seeds of paddy and of wheat in the total sown area under the crops has been used for this purpose. (2) Use of chemical fertilizers—The total consumption of chemical fertilizers (NPK in nutrient) per hectare of gross sown area in the district. (3) Use of machines—The total value of machines used for agricultural purposes, *viz.*, tractors, pumping sets (both electric and diesel) and sprayer and dusters in the district at average market prices per hectare of the net sown area. The method used for preparing the adoption index remains the same as that of the method used for preparing the index of infrastructure noted earlier.

TABLE II—COMPOSITE INDEX OF INFRASTRUCTURE AND SOME OTHER RELATED ITEMS IN THE THREE REGIONS AND BIHAR STATE AS A WHOLE

Items	North Bihar Plain region	South Bihar Plain region	Chotanagpur region	Bihar State
1. Composite index of infrastructure—regional averages*	92·54	143·88	50·51	100·00
2. Adoption index—regional averages* ..	110·43	130·02	36·20	100·00
3. Index of agricultural productivity** ..	104·22	112·19	73·00	100·00

Notes:— *Regional averages are computed by taking simple mean of the indices for the relevant districts included in the region.
**Regional indices are computed in relation to the figure (indicating the level of agricultural productivity) for the Bihar State as a whole which is taken as 100·00.

the Chotanagpur region. Average indices of infrastructure for the three regions turn out to be 50.51, 92.54 and 143.88 for the Chotanagpur Plateau, North Bihar Plain and South Bihar Plain regions respectively. The same pattern of differences between the three regions is also indicated with regard to the adoption of new agricultural practices and agricultural productivity (see items 2 and 3 in Table II). This may be taken to indicate that the low level of infrastructure in the Chotanagpur region has led to the smaller use of new agricultural practices and lower level of agricultural productivity in the region. This is also borne out by the significantly positive associations of infrastructure (INF) with the level of adoption (ADO) and the level of agricultural productivity (AGP) as indicated by the following log-linear regressions[6] estimated from the cross-sectional data of 31 districts of Bihar using ordinary least squares method:

$$\text{Equation 1}: \text{LogAGP} = 2.6254 + \underset{(0.0630)}{(0.4325^{***}\ \text{LogINF}} : R^2 = 0.6193$$

$$\text{Equation 2}: \text{LogAGP} = 2.944 + \underset{(0.0388)}{0.3651^{***}\ \text{LogADO}}: R^2 = 0.7532$$

$$\text{Equation 3}: \text{LogADO} = -0.7015 + \underset{(0.1163)}{1.1464^{***}\ \text{LogINF}} : R^2 = 0.7700$$

Notes applicable to the above equations and for the regression equations presented in the subsequent analysis.
(*i*) Figures in parentheses are the standard errors of the corresponoing regression coefficients.
(*ii*) * Significant at 10 per cent level (two-tailed test).
** Significant at 5 per cent level (two-tailed test).
*** Significant at 1 per cent level (two-tailed test).

6. There is an obvious shortcoming in the methodology when the infrastructural index has been used in the regression where agricultural productivity is the dependent variable, since the infrastructural index is weighted by the correlations of infrastructural items with agricultural productivity. This might inflect the degree of association between the composite index of infrastructure (thus computed) and the level of agricultural productivity but considering the extent of association (which is highly significant at 0·1 per cent level of significance) between the two, we thought that the consequences are not serious. Again the preparation of the composite index of infrastructure, using the weighted standard scores method for simplicity, has facilitated the extension of the inter-regional analysis with the help of Dummy Variables Technique (in terms of saving the degrees of freedom) presented below at the end of this section.

The above result (equation 1) indicates the fact that infrastructure is significantly related to the level of agricultural productivity in Bihar. It should be noted that the inter-district variation in infrastructure explains about 62 per cent of the variation in the level of agricultural productivity. Indirect association of infrastructure with agricultural productivity through the use of new agricultural practices is also indicated by the significant correlations between the extent of adoption of new agricultural practices (as measured by the adoption index) and the level of agricultural productivity, on the one hand (see equation 2) and between the level of infrastructure and the extent of adoption of new agricultural practices, on the other (see equation 3). The coefficients of independent variable in all the three equations are highly significant at 1.0 per cent level of significance.

We have also estimated the above equations for the three regions separately as an attempt to examine the regional differences in the responsiveness of the farmers towards the use of infrastructural facilities in the adoption of new agricultural practices and raising the level of agricultural productivity. These equations are presented below:

Region	(Equation 1 : LogAGP = a + b LogINF + u
NBP : LogAGP = 0.7398 + 0.8617*** (0.1846)	LogINF: R^2 = 0.6448, df. = 12
SBP : LogAGP = 2.7145 + 0.4051* (0.1882)	LogINF: R^2 = 0.3667, df. = 8
CNP : LogAGP = 5.1680 — 0.2263 (0.3475)	LogINF; R^2 = 0.0782, df. = 5
	(Equation 2 : LogAGP = a + b LogADP + u)
NBP : LogAGP = 1.8161 + 0.6023*** (0.1045)	LogADO; R^2 = 0.7346, df. = 12
SBP : LogAGP = 2.4850 + 0.4611** (0.1446)	LogADO; R^2 = 0.5594, df. = 8
CNP : LogAGP = 3.6002 + 0.1910 (0.2765)	LogADO; R^2 = 0.0871, df. = 5
	(Equation 3 : LogADO = a + b LogINF + u)
NBP : LogADO = 0.0052 + 1.0332*** (0.3244)	LogINF; R^2 = 0.4581, df. = 12
SBP : LogADO = 0.6106 + 0.8551*** (0.2362)	LogINF; R^2 = 0.6209, df. = 8
CNP : LogADO = 2.2407 + 0.3409 (0.5380)	LogINF; R^2 = 0.0743, df. = 5

Notes:— NBP = North Bihar Plain region.
SBP = South Bihar Plain region.
CNP = Chotanagpur Plateau region.

Above equations also indicate regional disparities in the response equations. We find that the elasticity coefficients for North Bihar Plain and South Bihar Plain regions in all the equations are positive and statistically significant but the elasticity coefficients are insignificant though positive except in the case of equation 1 (which exhibits negative coefficient) for the Chotanagpur region. The low elasticity coefficients (besides being insignificant) for the Chotanagpur region may be the result of a very low level of infrastructure in the region and it does not, however, indicate lack of response of agricultural productivity to infrastructure because the farmers of this region are not given equal opportunity to respond in the sense that a viable minimum of infrastructure does not exist (the level of infrastructure is considerably lower in the Chotanagpur region as compared to those in the plain regions of Bihar as noted earlier). Adoption of new agricultural practices that promote agricultural productivity might be forthcoming when adequate infrastructure was available and in the absence of such an adequate infrastructure, their adoption might not also be forthcoming.

The overall homogeneity of the regressions in the case of equation 1 and equation 3 between the three regions is rejected by the Chow test[7] used for this purpose. Further analysis reveals that the response equations (equation 1 and equation 3) for the pair of North Bihar Plain and Chotanagpur Plateau regions differ in their intercept as well as in slope as indicated by the significant coefficients of the intercept dummy and slope dummy variables in the regressions.[8]

CONCLUSIONS

The study reveals the existence of inter-regional differences in the level of infrastructural facilities in Bihar. Bihar Plain regions are suffi-

7. The computed F-values are 3·30, 1·60 and 6·89 corresponding to equation 1, 2 and 3. F-values corresponding to equation 1 and 3 at appropriate degrees of freedom ($v_1 = 4$ and $v_2 = 25$) are significant at 5 per cent and 1 per cent level of significance respectively.

8. The generalised dummy variables technique is used for testing as to whether the regressions for the pairs of regions differ in their intercept or in slope or both. The estimated equations are given below:

Equation 1 :

$$\text{Log AGP} = 4{\cdot}5616 - \underset{(0{\cdot}9540)}{3{\cdot}5588^{***}D_1} - \underset{(1{\cdot}2685)}{2{\cdot}1449D_2} - \underset{(0{\cdot}2284)}{0{\cdot}0713\ \text{Log INF}}$$

$$+\underset{(0{\cdot}2325)}{0{\cdot}8747^{***}}\ (D_1\text{Log INF}) + \underset{(0{\cdot}2925)}{0{\cdot}5292}\ (D_2\text{Log INF});\ R^2 = 0{\cdot}787,\ F = \underset{(5,25)}{18{\cdot}44^{***}}$$

Equation 3 :

$$\text{Log ADO} = 2{\cdot}6864 - \underset{(1{\cdot}4915)}{2{\cdot}8878^{*}D_1} - \underset{(1{\cdot}9831)}{2{\cdot}3720D_2} + \underset{(0{\cdot}3570)}{0{\cdot}2269\ \text{Log INF}}$$

$$+\underset{(0{\cdot}3635)}{0{\cdot}8520^{**}}\ (D_1\text{LogINF}) + \underset{(0{\cdot}4573)}{0{\cdot}6812}\ (D_2\text{LogINF});\ R^2 = 0{\cdot}908,\ F = \underset{(5,25)}{49{\cdot}20^{***}}$$

D_1 assumes 1 for the districts of North Bihar Plain region and zero, if otherwise and D_2 assumes 1 for the districts of South Bihar Plain region and zero, if otherwise. The coefficients of D_1 and D_2 and D_1 Log INF and D_2 Log INF represent the differential intercept and differential slope for the pairs of NBP and CNP and SBP and CNP region respectively. The usual t-test is used for testing the significance of the regression coefficients.

ciently endowed with the infrastructural facilities whereas these facilities are lacking very much in the Chotanagpur Plateau region. The same pattern of inter-regional differences in the use of new agricultural practices and the level of agricultural productivity is also indicated. It has been observed that the infrastructure is a significant determinant of the level of agricultural productivity in Bihar districts. Indirect association of infrastructure with agricultural productivity through the use of new agricultural practices is also remarkable. We find that the availability of infrastructure induces the farmers to go in for widespread use of new agricultural practices leading to higher level of agricultural productivity. On the whole, infrastructure contributes a great deal to modern agriculture and therefore a suitable policy for infrastructure with a rural bias is needed for economic development of the agriculturally based backward economies like that of Bihar.

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APPRAISAL OF INVESTMENT VIABILITY OF A DAIRY DEVELOPMENT CO-OPERATIVE FEDERATION IN NORTH-WESTERN INDIA

Milk is one of the most important components of enterprise-mix in Indian agricultural sector. However, low productivity, perishability and the seasonal nature of milk production prevent its profitable contribution to the total agrarian enterprise-mix in India. The technology of milk processing provides important know-how to circumvent these problems. Till very recently, milk processing industry could make only negligible contribution to the food processing industry in the country's private sector owing probably to unattractive return to private capital.[1]

Recently, with a view to improving the lot of both consuming and producing population, the public sector has been entrusted with the business of providing a milk marketing infrastructure. Thus, through various Plan allocations, it was made possible to install 92 liquid milk plants, 26 milk product factories and 68 pilot milk schemes throughout the country. This infrastructure has created milk handling capacity of about 10 per cent of total milk production in the country involving an investment of approximately Rs. 207 crores. The scope for creating additional milk marketing infrastructure over a period of seven years beginning from 1978 was also made with an outlay of Rs. 486 crores.[2] Such a massive allocation of funds to develop the country's composite milk marketing infrastructure has,

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1. "Manufacture of Dairy Products in India—An Analysis", Central Statistical Organisation, Industrial Statistics Division, Ministry of Planning, New Delhi, Bulletin No. ISD/4, 1979.

2. For details see, "Dairying in India", 17th Dairy Industry Conference, Ahmedabad, 1981, pp. 117-118.