INFRASTRUCTURE AND LEVEL OF AGRICULTURAL DEVELOPMENT IN BIHAR: FROM 1980-81 TO 1990-91

Dissertation Submitted to the School of Social Sciences, Jawaharlal Nehru University in partial fulfillment of the requirements for the award of the degree of

MASTER OF PHILOSOPHY

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CERTIFICATE

I, Kumar Virendra, certify that the dissertation entitled **"INFRASTRUCTURE AND LEVEL OF AGRICULTURAL DEVELOPMENT IN BIHAR: FROM 1980-81 TO 1990-91"** for the degree of **MASTER OF PHILOSOPHY** is my bonafide work and may be placed before the examiners for evaluation.

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KUMAR VIRENDRA

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CHAPTER - I
INTRODUCTION

1.1 Statement of the Problem:

"Agriculture was probably an ancient neolithic barbarian discovery and it was a great leap in human life. Human civilizations flourished on this agrarian base"[1]. The economists, sociologists, political thinkers, and planners and hold the view that the success of economic development programmes depends ultimately on the agricultural development[2]. It is particularly true in the initial stage of development. A developed agricultural system is a source of surplus capital, and by posting the people out of their own folds it also becomes a source for the supply of man power to the industrial and tertiary sectors of an economy[3].

"Development" is not synonymous to "growth" or "expansion". Development involves not only changes in quantity and size but also in contents, structure and direction. Agricultural development, as conceived here, means to evolve a system of agriculture practice that is quick in adoption to new conditions and capabilities development of its talent potentialities. It also means that the problem of agricultural development is not merely that of bringing in new technology for increased production but also that of changing the structural base including, of course, the human resources. The concept is, thus, a comparative one, that of other system.[4] In other words, Agriculture development is a function of change in physical and organic environment that is helpful in articulating the hidden potentials. It ensembles changes in cultural environment, technological, socio-political, economic factors etc. In a broad sense, agricultural development denotes an overall increase in the use of inputs and higher returns (income) from land. [5]

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[1] R.P.Mishra, "Towards a composite Approach to Agricultural Development", *The Indian Geographical Journal*; Vol. XLIII, Jan-Dec.1968, No. 1 To 4, p.

[2] Rajpati Ram, *Agricultural Development and Planning in Indian* (New Delhi: Criterion Publication, 1989), p.

[3] Bruce F. Johnston and John W. Meller, " Role of Agriculture in Economic Development", *American Economic Review,* L1, Sept. 1961, pp. 566-593

[4] R.P. Mishra op. cit. p.7

[5] D.N. Basu, Raghu Roy and Pallavi Nikhil, *Impact of Agriculture and Development on Demographic Behaviour* (New Delhi: Abhinav Publications, 1979), p.15

Agriculture has been synonymous with the rise and fall of culture and civilization in India for centuries. However it is paradoxical to know that though, there are more favorable climatic and other environmental conditions and higher labour inputs in the agriculture sector yet its contribution to the gross national product is very low in our country. The agricultural sector engages nearly 70 percent of the total work force while it contributes less than 36 percent in the gross national product. In its turn, low productivity of agriculture is largely responsible for India's poverty and fundamentally it is in this sector that the battle for long term economic development will be 'won' and 'lost'[6]. The country's prosperity depends on rapid economic growth and its in turn it depends on our performance in agriculture sector[7]. Therefore, 'by far the most critical issue of our development policy lies within agriculture and the rural economy.[8]

India has traveled a long way since independent as far as, agricultural development in concerned. The High yielding variety programme, which was introduced in the country in 1966-67, brought about a major change, a transformation affecting almost every sphere of Indian agriculture. Due to the use of these fertilizer responsive seeds, the yield per area has risen sharply in several crops, giving the country a much needed self-sufficiency in the production of cereals, and other crops. However, increase in the consumption of the modern inputs and irrigation along with the use of modern agricultural machinery, have also been equally contribution in breaking the age-old strangle-hold of the traditional, subsistent agriculture in India. This progress has been hailed as a revolution, popularly termed as 'Green Revolution'.[9] The green revolution' enables us to have a break from the 'hand-to-mouth' situation.[10] And to move forward ahead of our population growth and demand for food[11].

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[6] Gunnar Myrdal, *Asian Drama: An Enquiry into the Poverty of Nation* (London, Allen zone: Penguin Press, 1968), p.1033

[7] M.S Swaminathan, "New Technology Problems and Potentialities" in H.Shah and C.N. Vakil (Eds.), *Agriculture Development of India: Policy and Problems* (Bombay: Orient Longman Ltd, 1979), p. 455

[8] Tarlok Singh, *India's Development Experience* (Delhi: The Macmillan Company of India Ltd.,1974), p. 149

[9] T.C.Sharma, *Technological change in Indian Agriculture: A Regional Perspective* (Jaipur, New Delhi: Rawat Publications, 1999), p.7

[10] A.M.Khusro, "Agriculture as Business", *The Illustrated Weakly of India*, Feb 13, 1972, p.29

[11] CH.Shah, "Indian Agriculture: Transition to Modernization", *Commerce Annual*, Number 1983-84, Vol.149, No. 3840, pp. 7-26

Although, the introduction and spread of Green Revolution technology have brought substantial increase in agricultural productivity and over all production in recent years yet, the gains of such increase are said to have been shared unevenly by various factors of production. Inter-regional disparities in India's agricultural development may be largely attributed to uneven growth of capital and human skills over regions resulting mainly from the absence of an appropriate strategy of development.[12] It is important to note here that the states that have maximum number of its population and other resources engaged in agriculture have very low level of agricultural development. Bihar is one among such state in India.

Agriculture is a predominant sector of economy in Bihar involving about 80 percent of population of the state. Despite several attempts through various five year plans the process of agricultural development has not yet become satisfactory. The technological innovations which transformed agriculture in the north-western region of the country have not made any significant headway in Bihar. Yield levels are very low in the state. It is believed that in most part of the region the so called 'traditional technology' is highly prevalent. This is particularly important because as a matter of fact that majority of the farmers in the state are marginal, having poor investment capacity. There is a wide gap between the yield levels of the average farmers and those realized by some progressive farmers and also in demonstration farms though the state has numerous perennial rivers traverse the alluvial plains and the plateau region is richly endowed yet here agriculture largely depend on the monsoon rain. Thus, Bihar has been rightly considered a 'Land of paradoxes. It called so due to being richly endowed with fertile soil, irrigation potential, vast reserves of mineral wealth etc. yet it is economically among the most backward states in the country.

Bihar is one of the most flood affected states of India. According to one estimate about 16.5 percent of the entire flood prone area within the country is located in Bihar and also approximately 22.1 percent of the total flood affected population of the country resides in the flood plains of the state[13]. Flood inundates annually 69

[12] Binay Nath Verma and Hem Chandra Lal Das, " Regional Pattern of Agricultural Development in India (1891-1976): An Institutional Approach", *Indian Journal of Regional Science*, 1995, Vol. XXVII, No. 1and 2

[13] Rashtriya Barh Ayog, 1980

percent of the plain area during the Kharif seasons[14]. This implies that the number of persons hit by flood per unit area in Bihar is quite large and, in fact, it is the highest as compared to the other flood prone states within the country[15].

Like many other states of India, drought are common in the state, it is estimated that in a cycle of six years only two years are good agriculturally, two are adequate and the remaining two are drought years.[16] Drought causes wide fluctuations in yield, cropped area along with soil erosion and lack of nutrition in the soil start decline in the live stock and important component of agriculture in Bihar is another major environmental hazard in the state. It is ironical to know that though the state has large surface and groundwater resources yet only a little over 30 percent of gross sown area is irrigated. Out of the identified ground water potential, only about 25 percent has been exploited so far. Lack of proper utilization of these resources is alone not techno-economic in nature as many would believe. There improvement in irrigation and drainage alone will not be sufficient. In Bihar it is in socio-political and requires strong political will.

Land holding structure of the Bihar is also in critical situation. It is noted that out of 108.98 lakh area under cultivation in the state during 1980-85, as high as 46 percent of holdings belonged to the size class of "less than 1 hectare" operated by 88 percent of total cultivators, Another 46 percent of holdings belong to semi-medium farm in the size class of 2 to10 hectare. Area operated under large farms i.e. 10 hectares & above was a mere 8 percent. Area under large farms in the state, moreover, has been rapidly declining on account of divisions in the families as well as sale of land for investments elsewhere[17].

There are isolated incidents of industrial development in the state but it is noticed the pace of urbanization and industrialization has not been sufficient to absorb the annual addition in population. This has two grave consequences for the political

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[14] Sharal Kumar and Parveen Jha, *Development of Bihar and Jharkhand: Problem and Prospects* (New Delhi: Shilpa Publication, 2001), p.7

[15] Dinesh Kumar Mishra, "The Bihar Flood Story", *Economic and Political weekly*, August 30, 1997, p. 2206

[16] T.C.Sharma and O.Coutinho, *Green Evolution Gaps: A Geographical Analysis* (Jaipur: Rawat Publications, 1989), p.2

[17] Sharat Kumar and Parveen Jha, op. cit. p.7

economy of the state namely either there is a greater concentration of population in the rural areas or there is age, skill, and sex selecting out migration from the state.

Bihar's agriculture sector has been faced a major problem i.e. lack of agriculture infrastructure. It means all those conditions which are necessary for technology transfer from laboratory to farm without delay, easy credit, good extension service, education in modern farming practices, improvement of marketing and accessibility to these by a good road system, continue to remain elusive in the state. Thus the state continues to starve for want of necessary degree of dynamism.

To worsen the situation some of the important agricultural region of the state especially central Bihar has been highly affected by "Caste war." According to scholars cast war has been in existence due to inequalities in socio-economic hierarchy run along the disparities in cast hierarchy throughout Bihar. The exploitation becomes a crucial issue in violent clashes between the upper castes, the backward castes and the scheduled castes. The spatial distribution of the caste war shows that areas where rural population density is higher are prone to cast violence in Bihar. Due to the 'cast war' sometimes crops are destroyed and land is left without cultivation for a long period. This too causes low production of agriculture along with adversely affecting the agricultural development of the region as well as the state.

Therefore, it can be said that agricultural development of Bihar has been highly affected by physical, social, economic and technological factors. In this sense, Bhatia's[18] opinions are very precise. According to him agricultural productivity

[18] S.S.Bhatia, "A New Approach to Measure Agriculture Productivity in Uttar Pradesh, *Geography*, 1968, Vol. 93, pp. 244-60.

development is a function of a variety of factors including physical, social, economic and technological each acquiring its specificities as component in an interacting system over time. The combined effect of these factors, manifest itself in per hectare productivity in any given area so, it can be said that despite of all favourable condition for the agricultural development in the state, the state witnesses to is one of the agriculturally backward state in India.

1.2. Personality of the Area:

In almost quadrilateral shape, Bihar* lying approximately between $21^0$58' 10"N and $27^0$31' 15"N latitudes and $83^0$19' 50"E and $88^0$17' 40"E longitudes covering 173,877 sq.km. of geographical area (5.30 percent of the geographical area of India) and with 86,374,465 population contributes about 10.69 percent population of the country as 2001 census. It is the sixth largest and the second most populous state of India. It is extending to 605 kilometers from north to south and 483 kilometers from west to east at a height of above 173 feet (53 meter) from mean sea level.[19] The state is delimited in the north by the independent kingdom of Nepal, in the west by Uttar Pradesh and Madhya Pradesh, in the south by Orissa and in the east by West Bengal. Administratively, the state is divided into 13 divisions, 55 districts, 134 subdivisions and 743 C. D blocks as 2001 census.

Physiographically Bihar is a combination of plains, hills and plateau. It is the only state where the Indian plain and the plateau really meet. The state therefore, is geographically representative of the two major Indian physical units-the young unstable alluvial Indo-Genetic plain and the upland. River Ganga flows right across the state from west to east dividing it into two unequal parts. As evident from the Map no. southern portion being almost double the northern portion[20]. Approximately 46 percent geographical area of the state is covered by plateau. The geographical location of the state has significant impact upon other socio-environmental parameters particularly climate, vegetable economy and population.

The state has a hot summer, wet monsoon and day cool winter. Maximum temperature varies between 23^0C and 39^0C and minimum temperature between 9^0C

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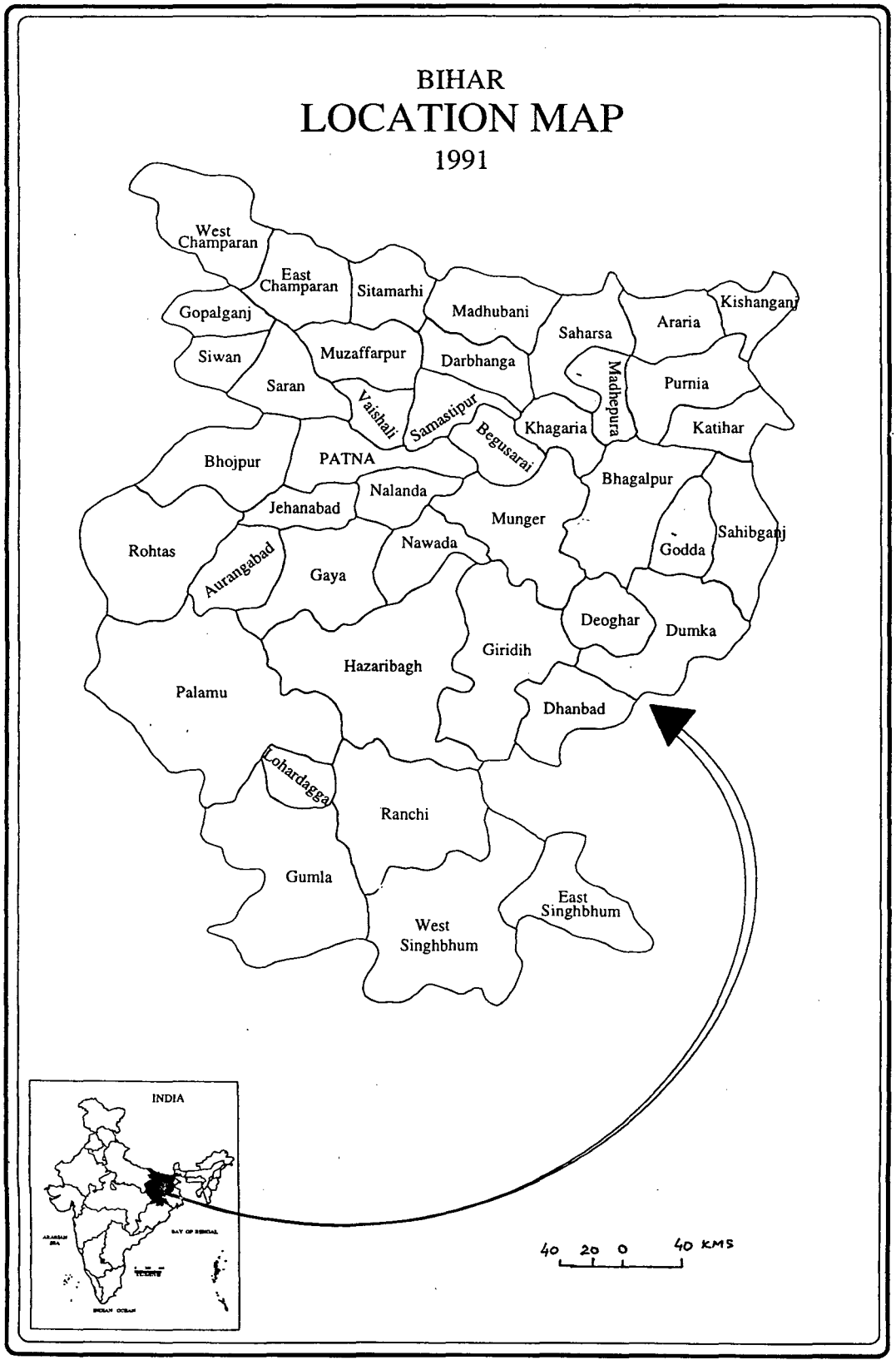
* United Bihar.

[20] Census of India, Bihar 1991

FIGURE NO. 1


BIHAR
LOCATION MAP
1991
West Champaran
East Champaran
Sitamarhi
Madhubani
Saharsa
Araria
Kishanganj
Gopalganj
Siwan
Muzaffarpur
Darbhanga
Madhepura
Purnia
Saran
Vaishali
Samastipur
Begusarai
Khagaria
Katihar
Bhojpur
PATNA
Nalanda
Bhagalpur
Jehanabad
Munger
Sahibganj
Rohtas
Aurangabad
Gaya
Nawada
Godda
Deoghar
Dumka
Giridih
Hazaribagh
Palamu
Dhanbad
Lohardagga
Ranchi
Gumla
East Singhbhum
West Singhbhum
INDIA
40 20 0 40 KMS

and 39^0C. Average annual rainfall in the state is around 1272 mm with considerable year's variations. Maximum rainfall occurred in the month of June to September by south –eastern monsoon. The whole of Bihar plains is practically an alluvial tract. The plateau region has red and yellow soils and black forest soils in some parts, which are not fertile. Large scale felling of trees leading to deforestation has accelerated the processes of soil erosion and aggravated degradation in unprecedented state. This put extra pressure on the large rural population.

About 86.86 percent population of the state is residing in the rural areas. Population density and sex-ratio of the state are 631per sq. km. and 911 females per 1000 males respectively during 2001 census. Literacy of the state is only 50.83 percent while only 26.72 percent of rural population was literates during the same year.

Agriculture is the mainstay economy of the states. Agriculture contributes 47.6 percent to the total state production. The agriculture sector provides livelihood for over 80 percent of its people. It was maintained before that the state has a total geographical area of about 173 lakh hectare. Out of them only 77 lakh hectares is the net sown area while 28 lakh hectares sown more than once-about 43 percent net sown area and 40 percent gross sown area receiving irrigation from different sources during 1990-91.

The crops cultivated in the state are dominated by food grains. About 95 lakh hectares (about 90 percent of the gross sown area) of the state is covered by foodgrains and remaining 10lakh hectares (10 percent of the gross sown area) is under other crops. Cropping intensity is about 136 percent for the state as a whole. Some of the principal food grains grown are paddy, wheat, maize and pulses. Main cash crops are sugar come, potato, tobacco, oit seeds, onion, chillis, jute and mesta. Forest cover is about 23 lakh hectares which is almost 17 percent of the geographical area.

Bihar is extremely fortunate in having a very high proportion of its total geographical area available for cultivation. For India as a whole, potential net sown area is estimated roughly at 47 percent of total geographical area, whereas for Bihar,

the same is estimated to be 61 percent[21]. The state has also as an online irrigation potential of 91.64 lakh hectare of which 65 lakh hectare could be realized through major and medium irrigation projects and 26.64 lakh hectare through minor irrigation schemes. According to one estimate its total replenishes able ground water resources estimated to be approximately 3.35213 million ha. m/yr in which 2.84931 million ha.m/yr. are available for irrigation. Moreover, it has equally high ground water potentials that can be used for irrigation. At present use of ground water for irrigation was 49.97 lakh ha. with a promises for 2.30255 million ha. meter/year balanced ground water resources in net terms is available for future use in the state'[22].

These few factual information shows that Bihar is enclosed with a high potential for agricultural development. But, due to lack of research knowledge about the potential of different regions of the state and insufficient infrastructural facilities for transferring tested technology from research institutes to farmers and their field, the agriculture production has not increased much. The available resources have not been fully utilized for undertaking problem oriented research in different regions. The present study makes a humble attempt in their direction with the following objective in mind.

1.3 Objectives of the Study

It is evident from the study of the personality of the study area that it possess a rich potentials for the growth of agriculture but it continue to be one of the most backward state in the country. Therefore, it is important to probe into the factors that constraint agricultural development in the state and particularly how infrastructure is responsible for the prevalent condition of agricultural development in the state from 1980-81 to 1990-91. The purposes of this study is not only to take up maximum elements of agricultural infrastructure possible but also to look into dynamic and regional aspects of agricultural infrastructure and their relationship with agricultural productivity and overall rural development. To be more precise the major objectives of the proposed study are given as following:

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[21] Parveen Jha, "Under development and Agricultural labour" in Sharat Kumar and Parveen Jha (eds.), *Development of Bihar and Jharkhand: Problem and Prospectus* (New Delhi: Shipra Publication, 2001), p. 33

[22] Central Water Board and State Ground Water Irrigation Organization, 1991

(i) to analyze the physiographic and socio-environment setting of the state which to a large extent govern agricultural development in the state over space and time.

(ii) to study the dynamics of landuse with special reference to the changes in net sown area, net irrigated area and land holding

(iii) to depict the distribution of different agricultural infrastructure among the districts of the state and its changing pattern during 1980-81 and 1990-91.

(iv) to measure the levels of agricultural development and its casual relationship with infrastructural development.

It is clear from the objective mentioned earlier that the study proposed to under taken an objective study of the spatial dynamics of infrastructure and agricultural development in Bihar. The theme under discussion are an out come of interrelation factors like natural, socio-cultural political, technological and economic. It is therefore imperative to identify some of the crucial factor for bringing the desired changes in the agriculture development. For this purpose the following hypothesis are proposed for investigation.

1.4 Hypothesis

Agriculture in Bihar date back into thousand of years in history and infrastructure too reflects continuous change. Therefore, it is a complex and multidimensional phenomenon. It is important to noted that the provision of agricultural infrastructural in a region is one thing and the use of these infrastructure is another thing. It may be possible that in spite of better availability of agriculture infrastructure the agriculture development does not occurs to the extent as expected due to their lack of appropriate uses. As mentioned earlier, the study revolve around the distribution of agricultural infrastructure among the districts of the state and its effect on the agricultural developments particularly agriculture production. To probe in to these aspects following research questions have been proposed for detail study.

(i) Disproportionate distribution of agricultural infrastructure is largely responsible to variation in agriculture development in the districts of the plain regions which have higher concentration of agriculture infrastructure than that of plateau region.

(ii) Distribution of agricultural infrastructure is largely determined by the physiographic charteris tics of the districts.

(iii) The districts with higher concentration of agricultural infrastructure have relatively higher agricultural productively in terms of Rs. per hac. and Rs. per agriculture workers.

(iv) Districts which have high availability of agricultural infrastructure have higher percentage of area sown more than once.

(v) With the decrease in the availability of agricultural infrastructure among the districts there will be less variations in the whole of agriculture production.

It is explicit from the hypotheses proposed above that in order to make the analysis more objectives a sound data base and equally adequate methodology is a must. Some of the important components of methodology and data base used here include selection of study units, indicators, data base and statistical and cartographic techniques.

1.5 Methodology and Data Base :-

It is discussed previously that there are no clear difference between agricultural infrastructure and other infrastructure. Therefore, infrastructure that directly or indirectly affects the development of agriculture may be considered agricultural infrastructure. The purpose of this study is to understand the role of these infrastructures in agriculture development in the districts of Bihar during 1980-81 and 1990-91 time periods.

1.5.1. Choice of Unit study:

In this study districts have been taken as the unit of analysis. Though districts do not conform to the homogeneous regions and sometimes homogeneous regions overlap inter districts boundaries. However, there are distinct advantages of taking districts as the unit of study due to availability of data. Reorganization of the districts on several occasion prevented the scholar from choosing the districts before 1980-81. It was because there was a sea change in the number of districts from 1970-71 to 1980-81 and 1990. There were only 17 districts during 1970-71 while it became 31 and 42 districts during 1980-81 and 1990-91 respectively. For the convenience of the present study, the numbers of district from the 1981 census have been taken. For this

purpose it became necessary to club some of the districts to regain their original position at 1981. The following table too explains the method of clubbing.

Old districts (1981)	The districts in 1991 clubbed into old districts		
a. Saharsa	i. Saharsa	ii. Madhepura	
b. Purnea	I. Purnea	ii. Araria	iii. Kishanganj
c. Gaya	i. Gaya ii. Jehanabad		
d.Munghyr	i. Munghyr	ii. Khagaria	
e. Santhal Pargana	i. Dumka	ii. Godda	iii. Deoghar
f. Ranchi	i. Ranchi	ii. Gumla	iii. Lohardaga
g. Singhbhum	i. East Singhbhum	ii. West Singhbhum.	

1.5.2 . Choice of Variables and Indicators:

After the selection of the district it was estimated to select the indicators

The choice of variables and indicators depends upon the availability of data related to the study, In the case of non-availability of data, sometimes important variables or indicators have been left. This study too was faced with such problems often it was noticed that paucity of appropriate information had made it difficult in the selection of appropriate indicators. Therefore indirect or surrogate indicator was selected some of the indicators selected are has been delimited to take more variables and indicators in this study, on the basis we have chosen nine indicators of agricultural infrastructure and three indicators of agriculture developments which is given below:

A. Agricultural Infrastructure

A1- number of pump sets energiesed per thousand of net irrigated area

A2- number of distribution transformers per thousand hectare of net sown area

A3- percentage of village electrified

A4- number of bank offices of Scheduled Commercial Banks in rural area per lakh of rural population

A5-outstanding credit (Rs.) in agriculture sector per agricultural Worker

A6- outstanding agriculture credit (Rs.) per hectare of gross sown area (GSA)

A7- Fertilizer consumption (in kgs) per hectare of gross sown area (GSA)

A8- gross irrigated are as a percentage of gross sown Area

A9- number of tractors per thousand hectares of gross cropped area (GSA)

B. indicators of Agricultural Development

B1- Agricultural productivity (Rs.) per agricultural workers

B2- Agricultural productivity (Rs.) per hectare gross sown area

B3- Cropping Intensity

To obtain the information for the above listed indication the following data source were used

1.5.3 Data Base:

The relevant data, used in the present study were collected for two points of time i.e. 1980-81 and 1990-91. Data for the present study has been collected from the following secondary sources. The main sources are:-

No.	Source	Data taken for the study
1.	Census of India, Bihar primary census abstract 1981 and 1991.	i. populating (total and rural) ii. Decadal population growth iii. Density of population iv. sex ratio v. literacy vi. agricultural workers (cultivator + agricultural labourers)
2.	Indian Agriculture statistics (Directorate of economic & Department of Agriculture, Govt. of India, New Delhi) 1980-81 and 1990-91	i. land use patterns ii. N.S.A. irrigated area statistics

3.	a. Bihar statistical Handbook, 1982, and	i. number of tractors ii. Number of pumsets energiesed
	b. Electricity statistics, 1982, 91-92 (Bihar electricity Board)	iii. Number of electrified village iv. Number of distribution transformer
4.	Banking statistics (Reserve Bank of India) 1980-81 and 1990-91	i. number of bank officer of ii. outstanding credit by scheduled commercial banks to agriculture sector
5.	Fertiliser statistics (The Fertiliser Association of India, New Delhi) 1980-81 1990-91	i. consumption of fertisers
6.	Centre for Monitoring Indian Economy (CMIE), July 1996	i. consumption of fertilisers ii. Area, production and price of the five crops i.e. rice, maize, wheat, gram and arhar

1.5.4. ***Limitation of the Data Base:***

It was mentioned previously that the choice of indicators for the study depends upon the availability of data; many inconsistencies were found with respect to districts and state level data. Therefore some important variables has been left important among these are number of oil engine pump sets, length of transmission and distribution lines (circuit in kms), percentage consumption of electricity in agricultural sector, number of agricultural credit societies, number of warehouse, number of marketing godown, number of fertilizer sale points, number of wholesale and regulated markets, area covered by HYV as percentage of gross sown area, number of agricultural scientists and extension service etc. on other hand, some data which are not available for the point of time of study, these were adjusted with the data of another point of time to complete the study. For example, outstanding credit in agricultural sector district level for 1980-81 has been taken from the year 1977; number of tractors in 1990-91 is based on 1995 etc.

Therefore it can be said paucity has considerably influenced the selection of indicators

1.5.5 ***Statistical Techniques:***

It is necessary to use appropriate techniques for the analysis of the study. In this study too, nine indicators of agricultural infrastructure and three indicators for showing agricultural development have been selected. After the selection of indicators the most important problem was to make them scale free. Therefore it was necessary to convert the entire indicator into some standard units to avoid their scale biased. There are various methods in use scale i.e. ranking method, division by some suitable value (like mean, standard deviation, coefficient of variation etc) and standardization. Though, each of them has its own merits and demerits and choice of any of these is not a value free decision.

In this study Principal Component Analysis (PCA) has been used to overcome the biasness of scale. In this method subtractions of mean and division by standard deviations have been done. To find the interrelation between the indicators of agricultural infrastructure and agricultural development regression analysis has been done. To find the level of agricultural development P.C.A. has been done. This technique is a branch of well known old multivariable technique of factor analysis. It is a technique designed primarily to synthesize a large number of variable into a smaller number of general components, which retain the maximum amount of descriptive ability.

The mathematical formulation of the "Principal component Analysis (PCA) was developed by Hotelling[23] in the following way:

Suppose $X= (X_1\ X_2.....X_p)$ be a set of P-vectors of standardized random variables having a good inter-correlations among them, the principal components of these p variables are such linear combinations of them which gives the maximum variance

[23] H.Hotelling , Analysis of a Complex Statistical Variable into Principal Component. *Journal of educational psychology*,193 3,vol 24,,pp407-41

Thus, if this required linear function is

$Y=a_1 X_1 + a_2 X_2 + \ldots\ldots + a_p X_p$

The coefficient vector $a_1= (a_1\ a_2\ \ldots a_p)$ must be such that:

(i) $S^2y = a'sa$, (i.e the variance of y) is maximum for all values of a and

(ii) $a'a = 1$ (a normalization condition for mathematics convenience)

Here s is the variance – covariance Matrix[24] of X and S^2y is the variance of y.

The objective of a principal component analysis is to find out the value of the coefficient vector $a'= (a_1\ a_2\ \ldots\ldots a_p)$ which statistics both the conditions given above.

The mathematical solution of this problem shows that 'a' is one often- eigen vectors, the number of components derived in this way are exactly equal to the number of original variables p' and the original total variance p[25] associated with (x $x_2 \ldots x_p$) is preserved exactly in the total variance of the components (y_1 $y_2 \ldots y_p$). Therefore the variance of a component is equal to the eigen value λ_i of the eigen vector[26] used for it.

On the basis of principal components Analysis' we have get the score for each district of the state and the districts have been ranked. Highest scores districts well have ranked 1 followed by others. PCA has been calculated for agricultural infrastructure and indicators of agricultural development and then correlate among them for the showing the effect of agricultural infrastructure on agricultural development in the state.

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[24] A variance-covariance matrix, of the variables $x_1\ x_2 \ldots x_n$ is a matrix whose diagonal clemerds show their variance and the off diagonal terms sij show the covariance between the variables x_i and x_j these covariance's is given by:

$$Sij= \sum(xi - \bar{x}i)\ \ (xj - \bar{x}j)/n$$

[25] Because $x_1\ x_2 \ldots x_n$ are p standardized variables cach having zero mean and unit variance the sum of their variances is 1+1+……+1 (p – times) = p

the descriptive power of each component is expressed as the ratio xi. The component which corresponds to the highest eigen value is known as the first principal component' The principal components which corresond to 2nd highest, 3rd highest, 4th highest…… and to the last eigenudlnes are known as second, third, fourth and the pth principal components. These principal components are statistically independent of each other.

[26] The eigen vector corresponding to each factor is derived from the formula

eigen vector= factor loading / eigen vector

This study is mainly based on the secondary data sources however the researcher has also benefited from the contribution made by other scholar on the similar thing. It is therefore necessary to briefly summarize the contribution of some scholar the following section tries to review the available literature.

1.5 Review of Literature:

It was mention earlier that agricultural development was nothing but an increase in the productivity and growth brought about by a continuous stream of new technical knowledge and a flow of industrial inputs like labour (human and capital), irrigation, fertilizers, improved seeds, etc. in which the new knowledge was embodied. Several studies have found that the scheme of raising agricultural productivity is heavily loaded in favour of the use of increasing quantities of purchased 'new' inputs. These inputs may be in the form of commodities, services and some additional factors. These additional factors, which facilitate the whole process of adoption of the use of new inputs fall under the infrastructural factors.

The concept of infrastructure is synonymous with the concept of overhead capital which was probably used for the first time by H.W. Singer. [27] He identified it with certain kinds of investments which are regarded necessary for development but are not directly productive in them. Nurkse[28] also elaborated the concept of infrastructure in his studied. He used the word 'social overhead capital' for infrastructure whose chief characteristics are "lumpiness". Further Nurkse[29] elaborated the concept and evolved certain criteria for the classification of overhead capital as well as infrastructure. Nurkse highlighted several characteristics of infrastructure i.e. these are basic for any productive activity, cannot be imported, require large and their installation calls for public assistance. These have long maturity period, lumpiness and high operational capital intensity and general external economics, Rostov[30], Hirschman[31](1958), and Healey[32] etc. also defined infrastructure

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[27] H.W.Singer, Development Projects as part of National Development Programe' in Formulation and Appraisal of Development Projects, 1951

[28] R. Nurkse, *Problems of Capital Formation in Under Developed Ccountries* (Oxford: Blackwell, 1955), p. 10,17

[29] R.Nurkse, " Some Reflections on the International Financing of Public Investment" in G. Harerler (ed.), *Equilibrium Growth in World Economy,* (Massachussetts:Havard University press, Cambridge, 1961)

[30] W.W.Rastov, *Stages of Economic Growth: A Non-communist Manifesto(* Cambridge University Press, 1962), p. 24,25

as overhead capital and its importance in the development of economic activity as well as development.

Through concept of infrastructure very wide sense and there is a lack unanimity the economists on the issues of inclusion and classification of elements under infrastructure.

Singer[33] has included education, health services, housing, transport, power and irrigation among infrastructure while Nurkse[34] has included public utilities, transport facilities, training schemes, water works,, power plants, hospitals, schools and basic services among infrastructure. North[35] has identified banking, insurance, postal facilities, warehousing and the development of a distribution system for import as infrastructure. Lewis[36] has covering ports, electricity, motor transport, irrigation and drainage scheme, government department concerned with "discovering new resources or discovering better ways of utilizing known resources" as infrastructure. Though Hirschman [37] restricted to transportation and power as hard core of infrastructure but in a broad concept, he has included law and order, education, public health, transport, communication, power, water supply as infrastructure. According to Roa[38], infrastructure is an essential instrument imparting elasticity to the supply factor. He has divided the various items of infrastructure into nine broad categories like transport, communications, energy, intermediate goods output, increasing productivity of natural resources, science and technology, information system, financing and banking and human resource development and into forty two subcategories.

Though there is no clear distinction between agricultural infrastructure and other infrastructure, therefore, attempts of conceptualization for the agricultural infrastructure have been rare in the literature. However, some of the works enlighten

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[31] A.O.Hirshman, *The Strategy of Economic Development* (Yale University Press, New Havens), p.83

[32] J.M.Healey, " Economic Overheads-Policy and Coordination" in Streeton and Lipton (eds.) *The Crisis of Indian Plannign* (Oxford University press, London), 1968, pp. 149-50.

[33] H.W.Singer, op.cit.pp.78.

[34] R.Nurkse, op.cit.note.24.

[35] D.C.North, "Industrialisation in United States (1859-60)", in W.W.Rostow, (eds),*The Economics of Take-off into Self-Sustained Growth* (Macmillan, London, 1964), pp. 44-62

[36] W.Arthur Lewis, *Development Planning: The Essentials Economic Policy* (George Allen and Unwin, London, 1966), pp. 97-102

[37] A.O. Hirshman, op.cit.pp.67-70

[38] V.K.R.V.Rao, "Infrastructure and Economic Development", *Commerce*, Vol. 141.No. 3628 p.9

on this subject. Nichollas[39] suggested that in the early stage of economic development, agricultural infrastructure should be taken up a social overhead capital. He has includes transport, education, agriculture research and extension services, banking and capital institution in the agricultural infrastructure. Deveries[40] classified agricultural infrastructure into "economic" and "social categories". He includes transportation, communication, power, health services, education, water supplies and housing in the categories of agriculture infrastructure. Wharton[41] classified agricultural infrastructure into "capital intensive" and "capital extensive" categories. In the "capital intensive" categories he included that item of infrastructure which heavily involves reproduction of capital for the precision of services, such as transport, communication, power installations irrigation and installations or organizations which operate and provide facilities like marketing, storage and processing. On the other hand, "capital extensive" infrastructures are those items in which capital component is relatively low, such as agricultural research and extension, education, conservation schemes, agencies catering to provide and post control organizations. Wanmali[42] classified the rural infrastructure in regarding to agriculture infrastructure into two categories – "Hard" and "Soft". Hard agriculture infrastructures refers to roads, telecommunications, electrification and irrigation while soft infrastructure includes various services such as transport (bus and truck), finance (credit and banking), input distribution (of seeds, fertilizers, pesticides, agricultural machinery, and husbandry inputs), and marketing (of agricultural and other rural produce) which is necessary for the development of agriculture.

The importance of role of infrastructure in agricultural development has been highlighted by a number of scholars. According to Anile[43], the developments of agriculture infrastructure have substantial effect on the agricultural productivity at

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[39] W.H.Nicholas, "An Agricultural Surplus as a factor in Economic Development", *Journal of Political Economy*, 1958, Vol.71.

[40] E.Deveries, "France for Development", Proceedings of the 10th International Conference of Agricultural Economists, London, 1958

[41] C.W.Wharton, "The Infrastructure for Agricultural Growth", in southwrh and Johnton (eds.), *Agricultural Development and Economic growth*,(Corrrwell University Press, 1967),pp. 34-35

[42] Sudhir Wanmali," Rural Infrastructure: The Settlement System and Development of The Regional Economy In Southern India", Research Report, 91 International Food Policy Research Institute, 1991, p.15

[43] S.M.Anile, "Infrastructure and Agricultural Productivity: Theory, Evidence and Implications for Growth and Equity in Agricultural Development", Universtiy of California, Daris for AGR, Economic, Working paper, 1983

both micro and macro level and, therefore, is a necessary condition for agricultural growth. Schultz [44] demonstrated the importance of infrastructure in the agricultural development by the 'Schultzian Model'. He has observed that the economic rationality of formers implies that their farms productivity depends on the perceived costs and benefits of the technological alternatives the face. He has argued that the effect of transportation and communication infrastructure on the costs and benefits are important determinant of farmer's choice of production technology and hence of farm productivity.

Ishikawa[45] has been delineated the essential ingredients of land augmenting the technical change required by most developing countries in Asia. According to him, among all indicators associated with progress in agricultural development only three are indispensable to rapid and prolonged growth in yields, improved water control, abundant supplies of fertilizers and high yielding seed varieties responsive to these inputs. Proper policy and institutions require establishment of broad based agriculture research extension and seed multiplication, delivery systems, transport and communications etc,

Ahmed and Hussain[46] have made a time series analysis of the relevant data on agricultural development in Bangladesh. Bruce Stone[47] Making an analysis of the next agricultural development and its implications for the infrastructure priorities for china. Hayami and Yamada[48] studied the effect of infrastructure in the agricultural development in Japan and show that besides limited land for cultivation, it has high productivity.

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[44] T.W.Schultz, Transforming Traditional Agriculture (Ann Arbor : The University of Michigan Press, 1964), pp.43-44

[45] Shigeru Ishikawa, "Economic Development in Asian perspective", *Tokyo, Kinokuniya*, 1967

[46] Raisudlin Ahmed and Mahboob Hussain, "Development impact of Rural Infrastructure in Bangladesh", IFPRI, Research Report No. 83, 1990

[47] Bruce Stone, "The Next Stage of Agricultural Development: Implications for Infrastructures, Technology and Institutions Priorities", IFPRI, Research Report 1990.

[48] Yujiro Hayami and Saburo Yamada, *The Agricultural Development of Japan – A country's Perspective* (*Tokyo*: University of Tokyo Press, Japan, 1991), p-106.

Mellore[49] argued that nearly 80 percent of the increment in output results from expansion in irrigation, increased use of fertilizers and the planting of high yielding verities. Yadav[50] stocked the role of institutional credit in the agricultural development of Nepal. He mentioned that the 'Agriculture Development Bank' of the country contributed 88 percent of total credit disbursed by the various institutional agencies and was created in order to institutionalize agricultural credit at the national level and incidentally to reduce the farmer borrowers dependence on landlords and money lenders. Due to this, investment in agricultural infrastructure of the farmers could be cured and they could be able to use proper inputs at appropriate time.

A number of scholars in India have been highlighting the importance of infrastructure in the agricultural development. Rao[51] argued that to keep the scales between technology and institutions, it may be suggested that in a technology favoured region to accent should be on endowment existing infrastructural investment. According to Bhalla[52], all vast variations in growth rules of agricultural production at the regional level point to the need for undertaking area specific measures to augment growth in lagging eastern and southern regions of the country. All these regions has lack of the appropriate infrastructure in irrigation, water management etc. so, in order to bring the logging states in the mainstream, what is required, apart from other things, is a huge investment in infrastructure.

There are no series attempt has been made to analyze the agricultural infrastructure and its regional dimensions in a dynamic time frame. Several works have dealt with this subject have dealt with only one single type of agricultural infrastructure facilities in isolation. Reddy[53] depicts an inter-district analysis of different sources of irrigation in the Rayalaseyma region in Andhra Pradesh. He argues that tank play protective role and act as pockets of insurance to crops. Tank

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[49] John W.Mellore, *The New Economics of Growth: A Strategy for India and the Developing World,* (Ithaca, New York: Cornwell University Press, , 1976), p.51-57

[50] Satya Bhan Yadav, *Institutional Credit and Agricultural Development in Nepal* (Delhi : Kalinga Publications, 2001), p.114

[51] C.H.Hanumantha Rao, *Technological Change and* Distribution of Gains in Indian Agriculture (New Delhi: The Macmillan Company of India Ltd, 1976), pp.45-48

[52] G.S. Bhalla, "Some Issues in Agricultural Development in India", in Ima Kapila (ed.), Indian Economy Since Independence, 1990, Vol.2, Chap.11, p.205.

[53] K.Ramakrishna Reddy, *Irrigation and Agricultural Development in India* (Delhi : Ashish Hashish Publishing House 995), p.78

irrigation contributes even in the worst of drought years, about 10 percent to gross irrigated area in the region. According to Dhawan[54], groundwater irrigation from private tube wells is an important factor in the new technology and uninterrupted cheap power availability largely decides agricultures performance. Lavania[55] studied the impact of bank finance on agricultural incomes and yields in Andhra Pradesh and indicate that farmers increased their yields and net incomes in major crops through improved technology availing short and medium term.

Singh [56] studied the impact of electricity on agricultural development in Varanasi region. Hussain[57] studied the role of education on the agricultural development in western Utter Pradesh. Such as more works has been done by many scholars to show the effect to one single infrastructure on the agricultural development. Besides these, some scholars takes more than one infrastructure to show the effect of these on agricultural development. Mukhopadhyay[58] has attempted to trace the sources of variations in agricultural productivity among 72 predominantly wheat growing districts of India diving the period 1959-60 and 1968-69. his finding indicates that "measured inputs" – land, irrigation, fertilizers, tractors, literate and illiterate labour – explain 40 percent of the variation in farm output. The remaining 60 percent is attributable mostly to what he calls "region effects" such as those associated with difference in climate which are none or less invariant over time, and to a minor temporal effects such as differential fluctuations in rainfall and other natural forces. Barnes and Biscounger[59] have made an attempt to study the impact on agriculture of electricity and other infrastructural improvements in 108 villages in three states of the country. This study has lacks of the regional dimensions. Similarly Kainthe[60] has studied the relationship between agricultural infrastructural facilities

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[54] B.D.Dhawan, Trends in Tubewells Irrigation 1951-78", *Economic and Political Weekly*, Vol.14, Nos. 51 and 52, Dec. 1979, pp. 22-29.

[55] G.SLavonia, et al., "Impact of Bank Income on Agricultural Incomes and Fields in Andhra Pradesh", *Financing Agriculture*, Vol. IX No, 1, April-June, 1977, pp. 12-15

[56] Surendra Kumar Singh, "The Impact of Electricity on Agricultural Development in the Banwaripur Group of Villages (Varanasi): A case Study", *National Geographical Jowenal of India*, Vol. XXIV, 1971, pp. 381-90

[57] M.A,Hussain, " Education And Agriculture Development: A Case Study of Western U.P." In Ali Mohammad (ed.), *Dynamics of Agriculture d Development in India,* 1979, pp. 133-40

[58] S.K.Mukhopadhyay, *Source of variations in Agriculture Productivity: A cross Section Time series Analysis in India* (New Delhi :The Mac mill an Company of India, , 1976), pp-80

[59] D.F.Barnes and H.P.Biscounger, Impact of Rural Electrification and Infrastructure on Agricultural Changes, 1966-1980", *Economic and Political Weekly*, Jan 4. 1986.

[60] G.S.Kainthe, "Infrastructure and Agricultural Productivity A Case study of Variations in Punjab", *Journal of Social and Economic Studies*, Vol.4 No.1, 1987

and agricultural productivity across the districts of Punjab. Shafi[61] has considered 10 variables including agriculture productivity, irrigation by canal, irrigation by tube, irrigation by other sources, area under HYV, Fertilizer consumption, Agricultural workers, Animal power , tractors power and agricultural credit in his study of regional imbalances in the agricultural productivity in Uttar Pradesh. The results revealed that the irrigation by canal, HYV area and tractor are the most powerful determinates in very high and high productivity region; irrigation by canal, HYV area, fertilizer consumption and credit in medium productivity region; irrigation by canals and tractors in productivity region. In his study, Bhalla and Alagh[62] have clearly shown how 69 districts accounting for 20 percent of the output consume 44 percent of fertilizers, employ 50 percent of tractors, 45 percent of irrigation pumps and have 38 percent of India's gross irrigated area. In their study of impact of new technology on agricultural production and resource productivity in Tarwa block of Azamgarh district in eastern Uttar Pradesh. Singh and Singh[63] concluded that the pace of adoption of HYV and new technology has been slow in the region because of inadequate capital available with the formers they revealed that cost of manures and fertilizers has been found highly significant with respect to both HYV and local varieties of paddy in the case of adopters whereas it is human labour in the case of non-adopters.

On the basis of the Brief survey of literature mention above it can be said that infrastructure play an important role in the agricultural development. The basic characteristics of the infrastructure may be outlined as:

(i) It is essential for development but it is not directly productive

(ii) It is the prerequisite of development

(iii) It is the non-Importable element.

(iv) It is lumpish in nature

(v) It generate external economics

(vi) It is provided by the state.

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[61] Mohammad Safi, "Agriculture Productivity and Regional Imbalances", *Concept*, Delhi, 1984, pp. 239-257

[62] G.S.Bhalla and Y.K.Alagh, *Performance of Indian Agriculture: A District Wise Study* (New Delhi: Sterling Publishers, 1979), p. 14, 74

[63] R.P.Singh and R.C.Singh, "Impact of New Technology on Agriculture Production and Resource Productivity in Eastern Uttar Pradesh", *Indian Journal of Economics*, Vol. 50(211), April 1973, pp. 431-44

Though, there is no clear distinction between agricultural infrastructure and other infrastructure. Therefore, the infrastructures which are intimately related with agricultural productivity as well as development may be considered as 'Agricultural infrastructure'. In the light of earlier discussion, the following elements may be considered as agriculture infrastructure.

(i) Irrigation – from all sources

(ii) Power generation and transmission of electricity

(iii) Transport – roads and railways

(iv) Communication – post and telegraph, broadcasting and Telecommunications.

(i) Credit and finance

(ii) Agricultural marketing

(iii) Education

(iv) Health facilities

(v) Research works,

(vi) Other elements like insurance, weather fore casting, agricultural promotional activities etc.

1.7 Schemes of Chapterisation

It is evident from the above discussion that the two important things under discussion i.e. rural infrastructure and agricultural development are complex and multidimensional. There is hardly any study available that has analyst the interrelationship between the two in case of Bihar. This research is a modern effort towards this. The study has the following important components in it or in other words the study has been conducted in the form of following schemes of Chapterisation.

i. Introduction

ii. Environmental setting and land utilization setting in Bihar

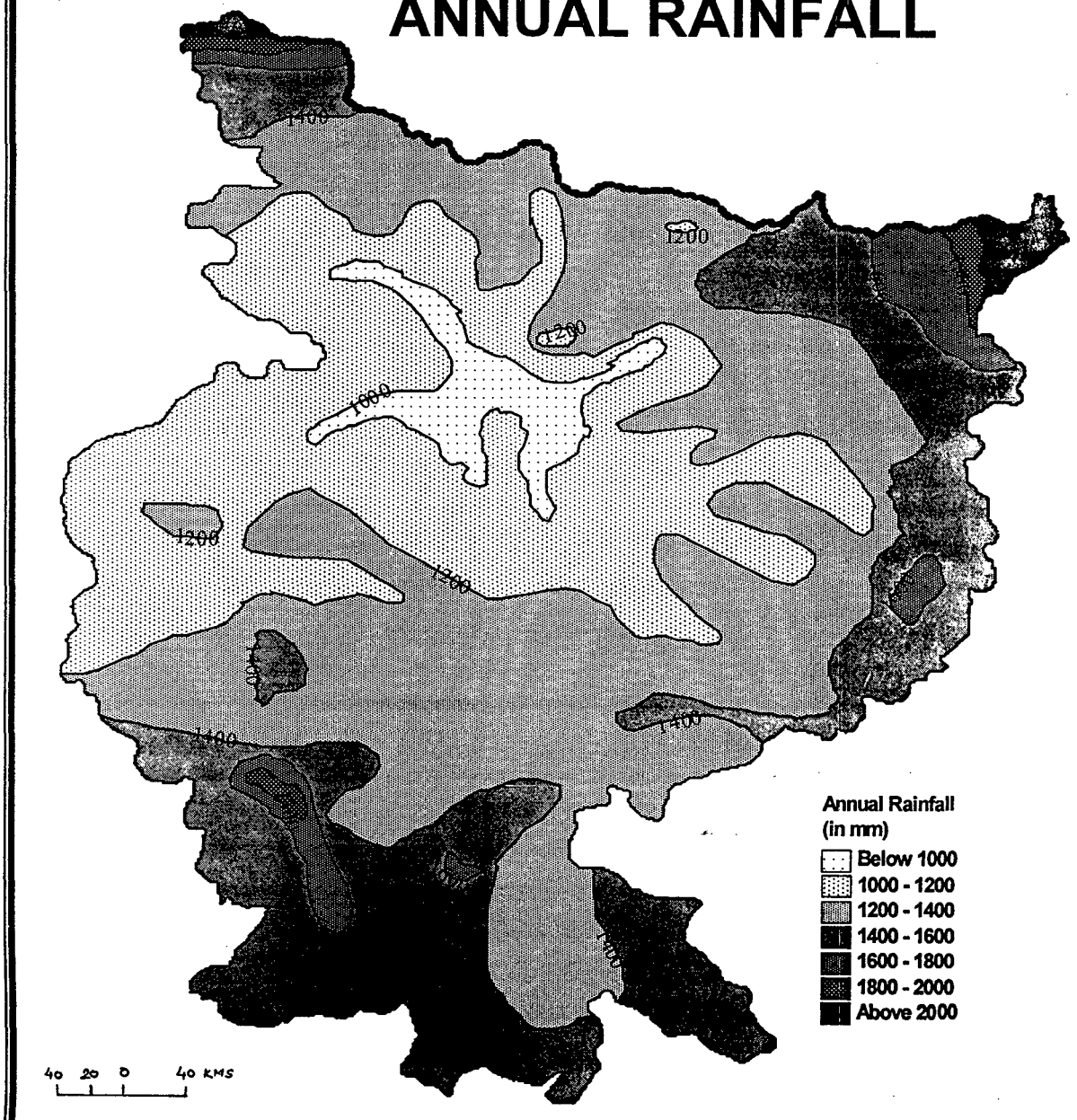
iii. Regional disparities in the distribution of agricultural infrastructure in Bihar.

iv. Level of agricultural development in Bihar.

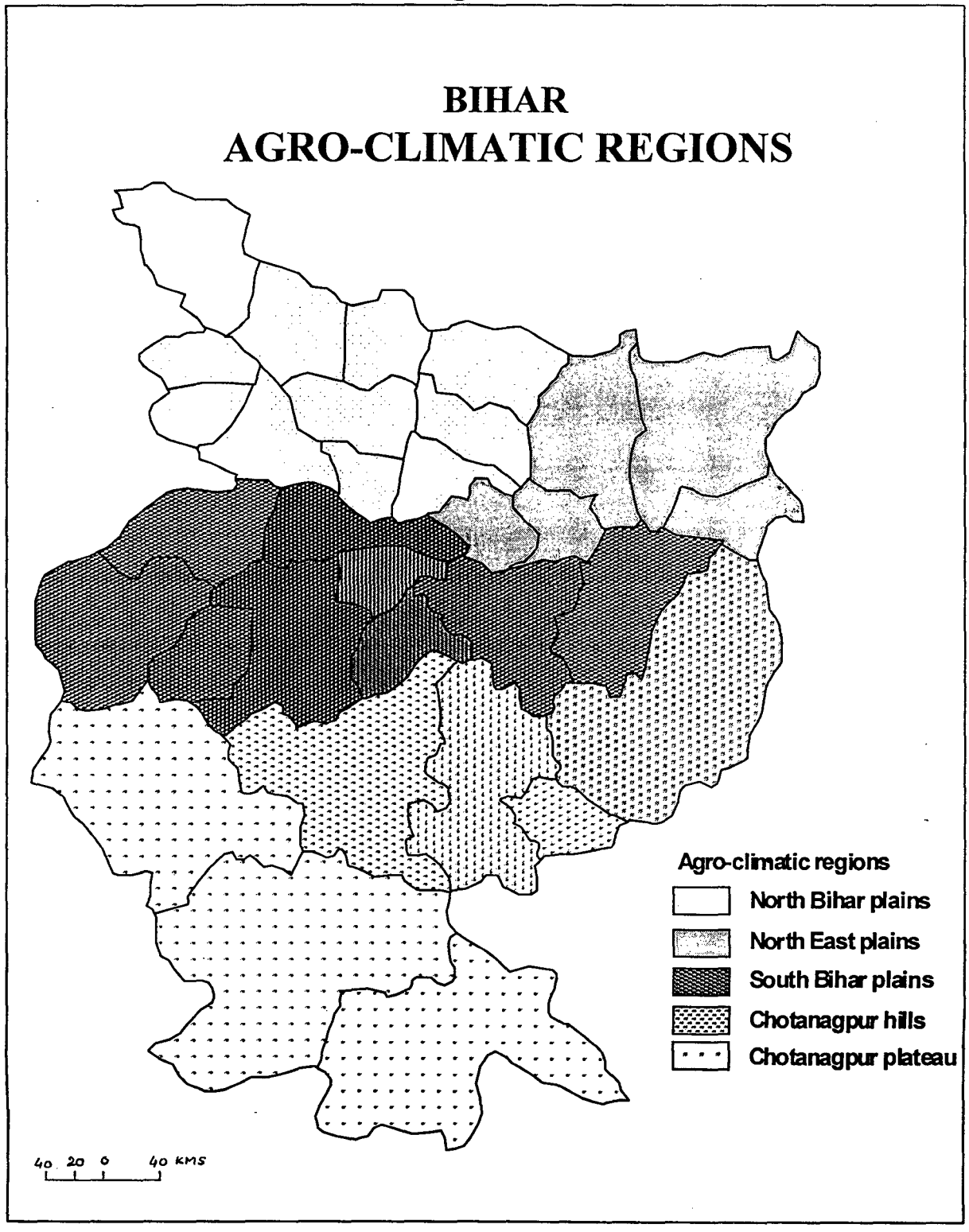
v. Infrastructure and agricultural development in Bihar.

BIHAR

ANNUAL RAINFALL



Figure


BIHAR
AGRO-CLIMATIC REGIONS
Agro-climatic regions
North Bihar plains
North East plains
South Bihar plains
Chotanagpur hills
Chotanagpur plateau
40 20 0 40 KMS

CHAPTER – II

ENVIRONMENTAL SETTING AND LAND UTILIZATION SETTING IN BIHAR

Agricultural development as well as distribution of agricultural infrastructure is the result of interaction of physical, social, economic, historical and political aspects in which first three are more important than the others. Mukhopadhyay[1] shows that nearly 60 percent of the variation in agriculture production is due to natural environment and innate human 'ingenuity. According to Singh[2], agricultural attributes are governed in a large measure, by the physical controls and thereafter modified by the socio-economic factors. It is necessary to discuss the previous aspects due to these factors have high effect on the agricultural development. In this chapter attempts have been made to study physiography, drainage, climate and agro-climatic region to understand the role of physical environment on infrastructure and agricultural development in Bihar. It also covers the demographic aspects like sex ratio, density of population, literacy etc., to study the nature of human response in relation to the above mention attribute of physical environment for agricultural development. Additionally, this chapter also attempts to study the land use pattern and land holding structure as an expression of land use dynamics in the state.

2.1 Physiography

According to census of India, Bihar has been divided into three major regions. These are –

i. *Himalayan Foothills* – This region is located at the extreme north-west corner as a small and narrow zone in the state. It is comprised of lower hills running along the Indo-Nepal border for a distance is 450 kms. This region shows backwardness in agriculture due to unfavorable condition for cultivation.

ii. *Bihar Plains* – It is a part of the great Indo-Ganga Plain with monotonously leveled surface often broken by protruding edge of southern plateau. It has a very

[1] Sudhir K. Mukhopodhyay,,Sources of Variation in Agricultural Productivity (T he Macmillion Company of India Ltd, Delhi, 1976), p.62.
[2] Jasbir Singh, An Agricultural Atlas of India, A Geographic Analysis (Kurukhsetra:Vishal Publication kurukhestra University, 1974), p.1.

gentle slope from the north-west to south-east while the southern side is an exposed Plateau shield with a steeper slope towards north-east. It is a featureless uniform plain however, river Ganga the main architect of the plain has also brought in some minor regional variations. On the basis of which it can be further sub-divided into the following region.

(a) North-Bihar Plains- It extends from Tarai region of Indo-Nepal border in the north and down upto the Ganga river channel. It is a riverine plain with very fertile land and is densely populated. Approximately 45 percent population of the Bihar lives in this region. The area in the north-east between Koshi and Mahananda is very much flood prone and frequent shifting of the channels of rivers is a common characteristics in this region which has seriously constrained the development of infrastructure and agricultural development. However, the fertile soil deposited during the flood season is been an important factor in replenishing natural fertility of the soil.

(b) South Bihar Plain: It is a narrow region lying to the south of river 'Ganga' gradually tapering from west to east. The 'Son' is the main right bank tributary of Ganga here. It is also a featureless plain occasional intercepted by low isolated hills like Barabar, Rajgir and Kharagpur in its eastern part of the region . Approximately 29 percent of Population of Bihar lived in this region

iii. *Bihar Plateau* – This region is generally known as the 'Chotanagpur Plateau'. It is comprised of a few smaller but contiguous small plateau like Hazaribagh Plateau, Ranchi plateau, Palamu plateau etc. Geologically it consists of Deccan lava. The region has steep slopes to its north, east and south while the western side exhibits a lesser slop with contiguity of Chattisgarh of Madhya Pradesh. Many important rivers flow out from this plateau. These include Damodar, Barakar, Subernrekha, South Koel and North Koel etc. These rivers are the perennial sources of Hydro-electricity generation by building dames across the rivers at the gateways of the plateau. The entire plateau is very rich in mineral deposits; It is also called the "Golden land of Bihar".In this region, the land is relatively infertile, particularly in the upland tracts, and population less than in the plains and agriculture is less intensive. These physiographic characteristics have an inter dependence relationship with the

drainage of the area which in turn also provide basis for the development of both agriculture and infrastructure for the development of irrigation facilities

2.2 Drainage System

It is evident from the map that Ganga is the main river of the state. However there are some smaller yet important river of the state. There are most significant from the point of view of irrigation and hydroelectricity generation. Bihar may broadly be divided into two drainage system –

(i) The North drainage system or the Ganga river system – the Ganga enters the state through Bhojpur district and passes out towards east, maintaining more or less a parallel course along the Himalayan range. It is a perennial rivers. It has a large number of Himalayan tributaries like Ghaghara, Gandak, Koshi etc. meeting at different places from north. Koshi is regarded as the most wildest river notorius for its flood and devastation. It is therefore, known as the "Sorrow of Bihar'. Tributaries comes from south are non perennial rivers with shallow beds.

(ii) The Southern Drainage system: The rivers like the South Koel, North Koel, Subarnrekha, Damodar, Barakar, Ajay, Mor, Konar, Bokaro etc. comprise this system. These rivers have been occasionally associated with rapids and falls depict the characteristics of shallow wide bed, dry in summer. However these rivers have nigh potentialities of hydroelectricity and irrigation.

The drainage and physiography of the region have an intricate relationship with the climate of the state and the combined effect of them is reflected in the development of infrastructure and agricultural development.It is therefore necessary to study the climate.

2.3 Climatic Conditions: Of all physical factors which influence agriculture, most significant in climate and particularly rainfall and temperature are the two most important climatic parameters. South-eastern monsoon is the main source of rainfall in the state. It has an average of four months duration from June to September in the state. The amount of rainfall varies over space and time. The north-eastern part receivs more rainfall and it gradually decreases towards west. The state receives

approximately 1272 mm rainfall during this period. The variation in rainfall ranges between 1000 mm to 2000 mm. The maximum normal annual rainfall above 2000 mm occurs at the extreme north-east and north-west corner of the state and along the Himalayan foothills in the north. The southern districts on the plateau also receive considerable higher amount of rainfall around 1400 mm. The central part of the state remain comparatively dearth of rainfall..July and August receive maximum rainfall and winter month particularly November and December remain relatively dry. The north-eastern monsoon, also known as the returning monsoon, has little effect over the state. Occasional showers in the form of cyclone do occur. Sometimes over the south-eastern part of the state. It is mainly due to the side effect of the low pressure that infrequently forms over the Bay of Bengal. Though the amount of rainfall received in the winter is generally scanty and infrequent however, it is most significant for the winter Rabi crops.

The spatial and temporal variation in the distribution of rainfall has significance influence on the agricultural and infrastructural development in the state. It is a well known fact that Bihar has immense potential for the development of modern irrigation system like canal and tubewells but due to certain institutional factors and government policies their possibilities continue to elude. As a result agriculture is mostly rainfed in the state.

The combined effect of all these have been articulated in the form of agro-climatic regions in the state.

2.4 Agro-Climatic Zones

According to ICAR(Indian Council of agricultural Research),United Bihar is divided into five agro-climate sub-zones. These are-

(i) North Bihar Plains/North West Alluvial Plains : This zone covers 18.19 percent of the total area of the state and it has 31.70 percent of the population of the state. It includes the district of west and East Champaran, Gopalganj, Siwan, Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Darbhanga and Samastipur.The land of this zone slopes towards south-east direction with a very low gradient. Major rivers through this region are Gandak, Burhi Gandak and Ghagra flowing.

Though this zone covers approximately 31percent cropped area of the state but nearlly 17 percent land in East Champaran, Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Darbhanga and Vaishali districts are salt affected and only about 26 percent of cultivated area of this zone is under irrigation. The rest is rainfed. Frequent floods, droughts, water logging in Gandak command area, numerous "chours" (low lands) and deficiency of nutrition in the soil are causing low yield of crops.It is suggested that the productivity of crops in this zone could be enhanced by adopting improved seeds and agricultural infrastructure at appropriate time.

(ii) North Eastern Bihar Plains/North East Alluvial Plains: As shown in the map no.2.1 this zone covers 11.68 percent of the total area of the state and it has contributes 13.62 percent of the total population of the state. This zone includes the districts of Saharsa, Purnia, Katihar and Begusarai.This zone covers 17.14 percent cropped area of the state. It has many streams and abandoned or activel channels of Koshi, small lakes and shallow marshes. About 50-60 percent area of this region are affected by flood and water logging of different magnitudes. Heavy leaching of soils have created acidity and nutritional disorders in their otherwise fertile land.

The northern part of Saharsa and Purnea have less risk of flooding, therefore use of high yielding variety seeds and agricultural infrastructure are relatively more developed and these have high potential for agricultural development.

(iii) South Bihar Plains/South Bihar Alluvial Plains: This zone covers 23.71 percent of the total area of the state while and has a share of 29.39 percent population of the state. It includes the districts of Bhojpur, Rohtas, Aurangabad, Patna, Gaya, Nalanda, Nawada, Munghyr and Bhagalpur.

This zone covers 26.77 percent cropped area of the state. There is a substantial chunk of land in Aurnagabad, Gaya, Rohtas, Munghyr and Bhagalpur that suffer every year from drought. Water logging in Bhagalpur and Son command area causes the low production of crops.Looking the agro-ecological conditions of the regions it can be said that this zone has great potential of agricultural development by timely supply of fertilizers, seeds and irrigation.

(iv) Chotanagpur Hills, This zone covers 20.28 percent area of the state and a shares 14.28 percent population of the state. This includes the districts of Hazaribagh, Giridih, Dhanbad and Santhal Pargana. This zone covers only 8.23 percent cropped area of the state. Soil erosions, soil acidity, erratic rainfall, poor water retentive capacity of soil are some of the important environmental problem here. Effective soil and water conservation and improved input may offer better potentialities for agricultural development in future.

v. Chotanagpur plateau: This zone covers 26.14 percent area of the state and contributes 11.01 percent population of the state. This zone is undulating with occasional plains, hills and plateau. Hill areas have the problem of soil acidity, poor fertility, shallow soil depth and erosion resulting in poor crop yield. The most important constraints of this zone are late arrival or early cessation of monsoon, high temperature leading to atmospheric drought situation continue to play a gamble with the farmers on the one hand and deterioration in the micronutrients and increase in soil toxicity on the other.

This zone have high potentialities for agricultural development provided proper soil and water management combined with assured supply of modern input are supported to the farmers in land.

2. 5 Population

It is clear from the above discussion that there are numerous environmental constraints in the development of agricultural infrastructures and development of agriculture in the state. These have greatly influenced the socio-demographic attributes in the state. The following section tries to study some of these demographic parameters. United Bihar covers 5.3 percent geographical area of the country while contributed 10.60 percent population of the country as 2001census. It was mentioned earlier that physiography plays an important role in the distribution of population. North Bihar Plains, South Bihar plains, North eastern plains, Chotanagpur hills and Chotanagpur plateau shared 31.70, 29.39, 13.62, 14.28 and 11.01 percent population of the state respectively. This shown that about three fourth population of the state residing in the plain regions of the state.

The largest proportion of population of the state reside in the rural areas which contributes about 86 percent(2001 census) population of the state. The proportion of rural population is much higher in the north and western part of the state. It is ,mainly confined to the district endowed with fertile soil, higher percentage of arable land, availability of ground water, good irrigation facilities. These same factors are also true for the higher density of population in the other districts of the Bihar plains across the Ganga too.

The districts where concentration of mining activity or industries taken place, the percentage of rural population relatively low. Dhanbad, Singhbhum and Ranchi districts are the example with about 48, 66 and 77 percent population of the districts resides in the rural areas. Patna is exceptional districts in plains areas where about 61 percent population of the districts reside in the rural areas. Otherwise all districts in the plains areas have more than 85 percent of the total population living in the village.

2.5.1 Population growth-Looking at the rate of population growth it was estimated that the decadal growth was 25.81 percent for the state during 1991-2001. The districts-wise data shown that Seohar district had highest decadal growth i.e. 36.16 percent followed by Vaishali (35.23 percent), Giridih (33.08 percent) etc. while Paschim Singhbhum, shown lowest decadal growth i.e.16.35 percent followed by Gumla (16.60 percent), Dumka (17.31 percent), Nalanda (18.64 percent) etc.

Similarly there were variation has been found in the density of population in the state.

2.5.2. Population Density – Bihar has a high population density with 609 persons/km^2 against a national average of 324 persons. Highest population density found in the plain region where fertile soil, availability of arable land, ground water and irrigation facilities are well developed. As opposed to there population density is low in the districts that have rugged terrain low level of irrigation facilities, poor communication system, poor quality soil etc. most of these are in the southern part of the state. However, there are a few isolated packets in Dhanbad, Ranchi and Purbi Singhbhum districts which depict a very high density. These pockets consists of industrial urban centers which push the density to strikingly very high level.

In plain regions, Patna (1471), Darbhanga (1442) and Vaishali (1332) districts show highest population density due to historical and administrative importance.

2.5.3 Sex Ratio – There are 931 females per thousand males in the state as against the all India ratio of 933 (2001 census). As table (2.2) shown highest sex ratio has been found in the south Bihar plateau region. It is due to the male selective out migration from the districts for education or job opportunities. Siwan districts shows highest sex ratio in the state i.e. 1033. It is due to the similar reasons as most of the male out migrate from the districts for job getting for pursuing education.

Dhanbad and Patna districts have shown lowest sex ratio in the state i.e. 874 and 873 respectively. The main reason for lowest sex ratio in Dhanbad districts is due to the development of the districts as mining centre. Patna is the capital of the state which attracts large number of male from other districts for job or educational facilities as a result it has low sex ratio.

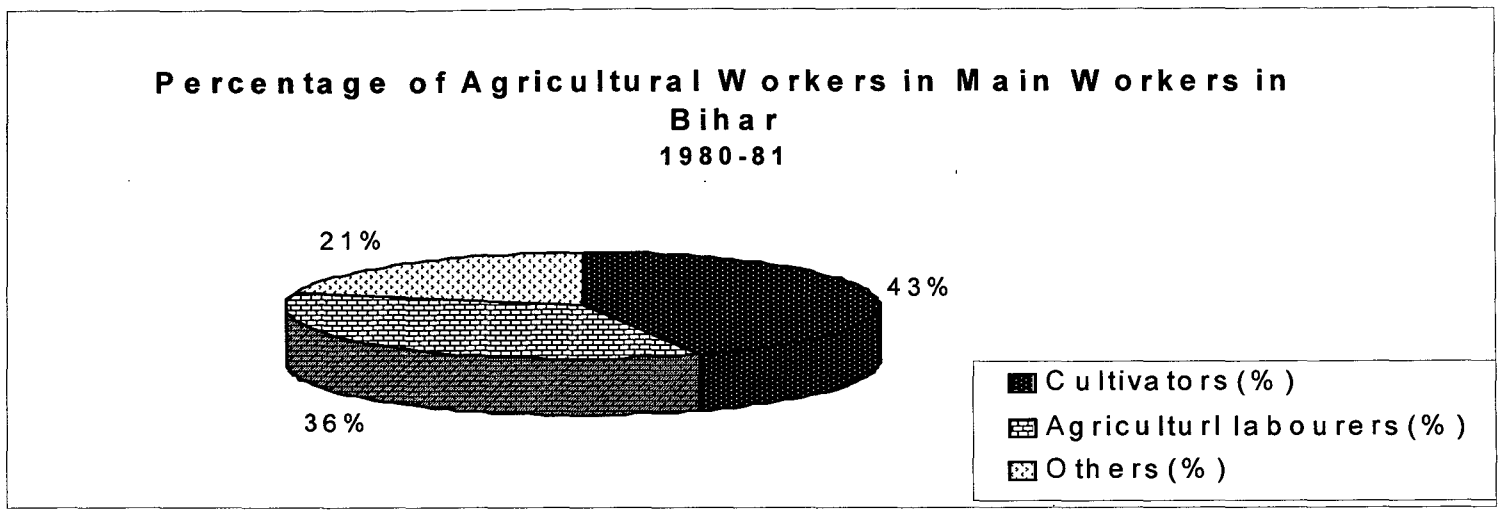
Apart from environmental reasons for uneven distribution of population the economic opportunities too provide valuable explanation for the same.

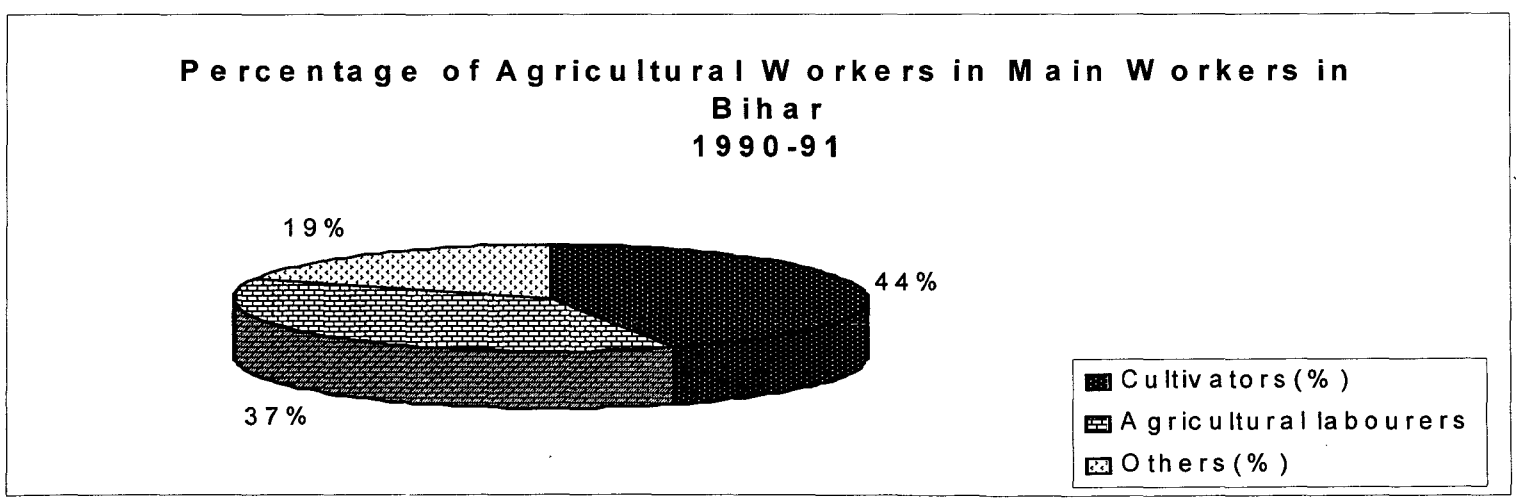
2.6 Agricultural workers.

Agricultural workers play a vital role in performing a number of agricultural activities. The agricultural sector provides livelihood for over 80 percent people in the state. The pre-dominance of agricultural activity is evident from the fact that population of the state is basically rural.

According to 1991 census, out of 44.84 million worker in the state of age group 15-59, the number of main workers was approximately 25.62 million (57.13 percent). Out of these 25.62 million main workers, 82.36 percent were engaged in primary followed by secondary (4.64 percent) and tertiary (13.00 percent) sector respectively. Out of these 82.36 percent of main workers engaged in primary activities, there were 82.71 percent were engaged as agricultural workers. It is also shown in the appendix (2)

PERCENTAGE OF AGRICULTURAL WORKERS IN MAIN WORKERS IN BIHAR





This table also shows that all the districts have above 80 percent agricultural workers except Dhanbad, Patna, Singhbhum, Hazaribagh, Giridih and Ranchi where percentage of agricultural workers were 29.04, 61.85, 65.66, 69.50, 72.74 and 76.32 percent respectively. Dhanbad district has been predominant by mining activities centre. Singhbhum and Ranchi are predominant heavy industrial centers. So, out migration of agricultural workers from industrial areas at high rate is largely responsible for low purchase of agricultural workers in these districts.

An important reason for over dominance of agricultural worker is low level of skill formation in the state. Literacy is largely considered to be the basic input in skill formation everywhere and Bihar is no exception. Moreover, an skill is perceptible to the use of modern input and use of modern agricultural infrastructure. Therefore, literacy is important both for agricultural development and use of modern infrastructures.

2.7 Literacy

As 2001 census there are 50.83 percent persons are literates[3] in united Bihar. Literacy in the rural areas are 45.34 percent. As appendix (1) shows that the districts in the south Bihar plains have higher rural literacy rate as compare to districts of other regions . Rohtas districts has highest rural literacy rate i.e. 60.32 percent followed by Bhojpur (57.34 percent), Aurangabad (56.06 percent) etc, while Kishanganj district shows lowest rural literacy rate i.e. 27.68 percent followed by Pakaur (28.14 percent), Katihar (31.19 percent) etc. Rural literacy of the state increased by 69.68 percent during 1991-2001 period.

The net out come of these afore said factors from the point of the presence reseach are articulated in the nature of land use pattern and land holding.

[3] "According to census the term "literate" is defined a person who can both read and write"

2.8 Land Use Pattern

Land use pattern of any region shows the availability of land towards different uses. The study of land use pattern is necessary to know about the availability of land for cultivation.In the case of Bihar there was 44.45 percent of the total area put under net sown during 1990-91. Table (2.5) shows that the districts in the North Bihar plains have large net sown area. It ranges between 52 percent to 80 percent, while in the Chotanagpur region it ranges between 16 percent to 33 percent. Due to rugged, hilly and forest covers the plateau region has scarce land available for cultivation. Siwan shows highest net sown area i.e. 78.37 percent of reporting area. It was followed by Bhojpur (77.98 percent), Nalanda (77.97 percent), Gopalganj (77.35 percent) etc. Hazaribagh has lowest net sown area i.e. only 16.76 percent followed by Palamu (17.29 percent) and Giridih. Table also shows that net sown are in the state has been decreasing from 1980-81—1990-91.It was 47.98 percent in 1980-81and 44.45 percent in 1990-91.Such a decrease was largely due to increased in the area under forests, land not available for cultivation and follow land .

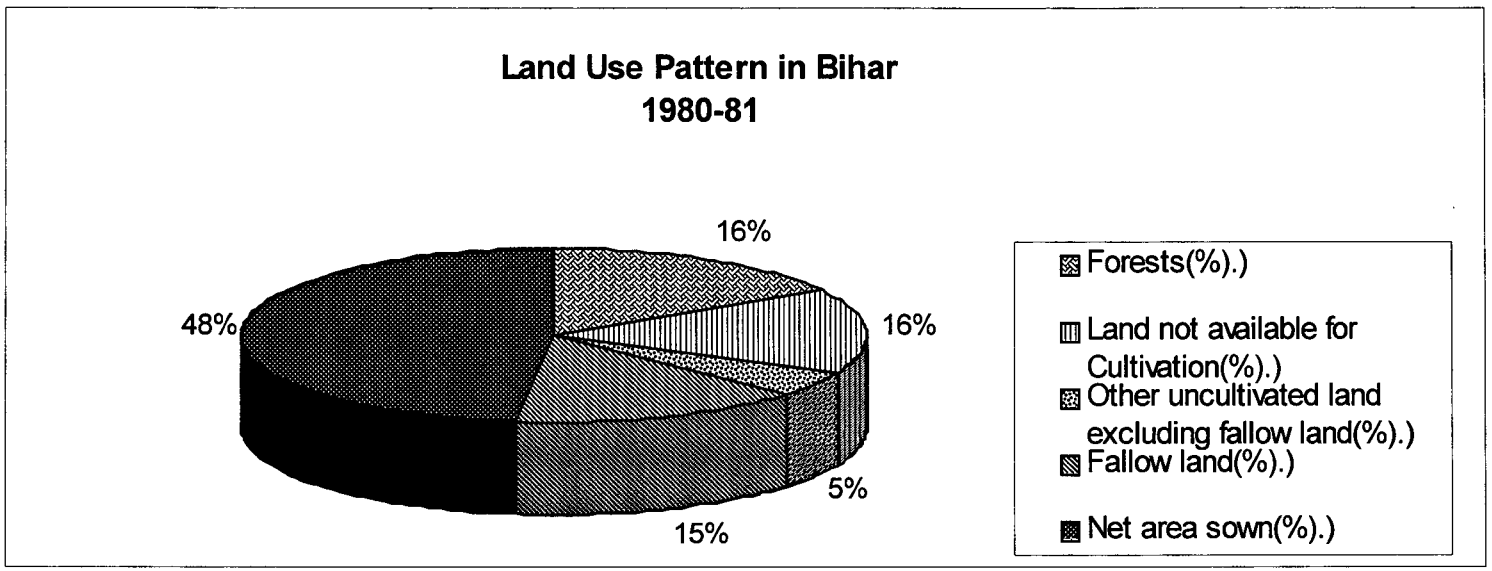
2.9 Land Holding Structure:

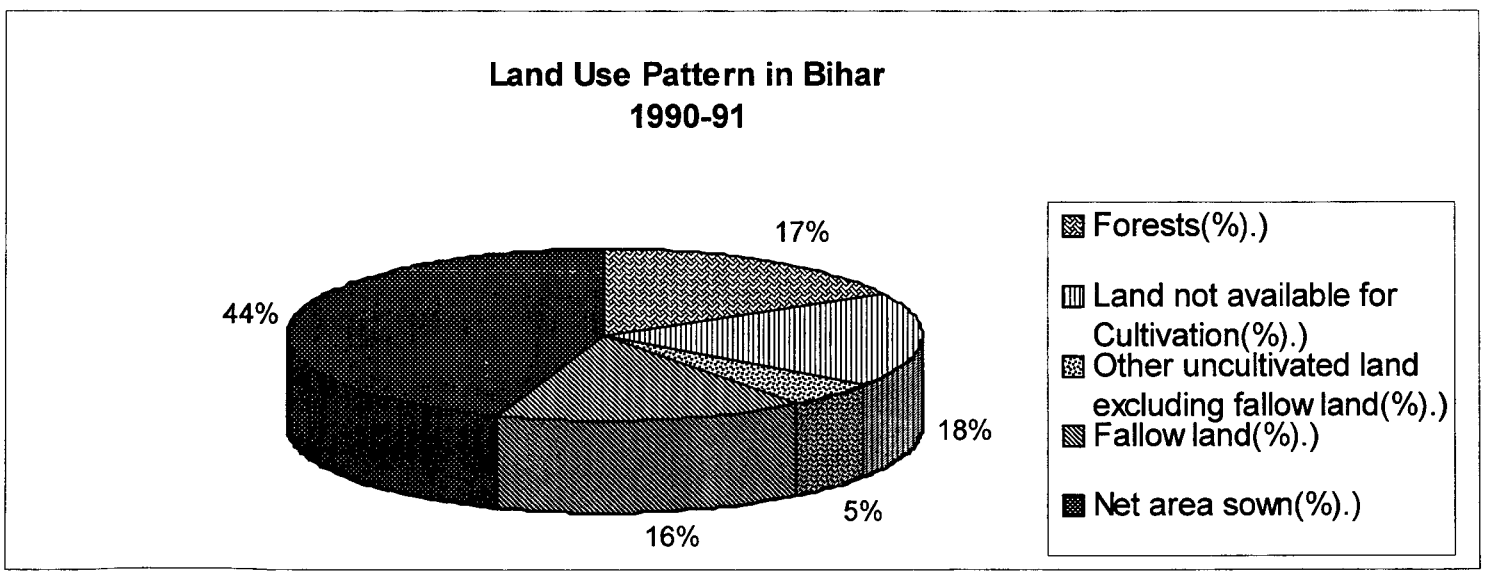
The Operational holding is the fundamental unit of decision making in agriculture Operational holdings envisages the land which wholly or partly is used for agriculture production and is operated by one person alone or with the assistance of others, without regard to title, size or location. Moreover, livestock kept for agricultural purposes without owning agricultural land is also considered part of holding[4].

The size of holdings in Bihar shows a close correlation to the pressure of population on land. It is experienced that due to the increasing in population and fragmentation of families the number of marginal holdings are increasing in the State. Thus it is a major problem in the agriculture sector in the state. Due to the small holding size i.e. 0-1 hectares, there is a problem to invest in agricultural infrastructure at high level. Thus small holding cause a serious constraint to agricultural development in the State.

[4] Mohammad Shafi, "Agricultural Productivity and Regional Imbalances", Concept, Delhi, 1984 p.43.

LAND USE PATTERN IN BIHAR





In Bihar, the largest number of operational holding are under marginal (0-1 hectares) holding. These accounts for 76.65 percent of the total number of operational holding in the state. It is followed by small, semi medium and medium operational holding which constitutes 11.33, 8.12 and 3.45 percent of the total number of operational holding in the state. The number of large operational holding (10 ha & above) shared only 0.44 percent of the total number of operational holding in the state.

Table 2.1: Land Holding Structure of Bihar

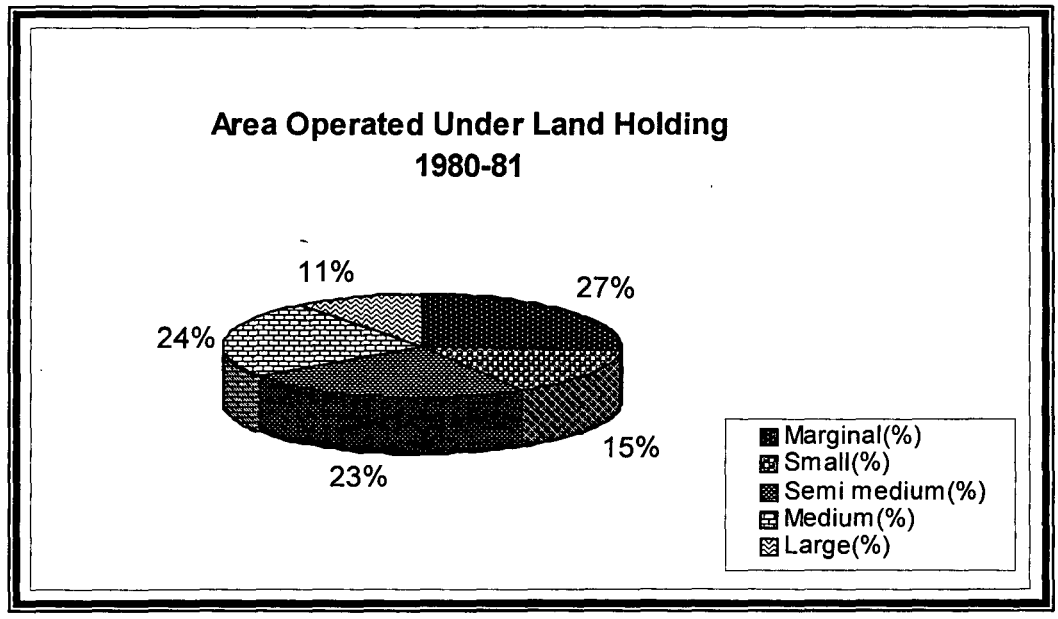
Types of operational holding	Number ('000)		Area Operated Hectares		Average Holdings Hectares	
	1980-81	1990-91	1980-81	1990-91	1980-81	1990-91
1. Marginal (0-1 hectares)	8521	8976	2952	3308	0.35	0.37
2. Small (1-2 hectares)	1218	1327	1648	1869	1.35	1.41
3. Semi Medium (2-4 hectares)	951	951	2594	2593	2.73	2.73
4. Medium (4-10 hectares)	472	404	2709	2293	5.74	5.68
5. Large (10 hectares & above)	68	52	1165	839	17.13	16.13
Bihar	11230	11710	11068	10898	0.99	0.93

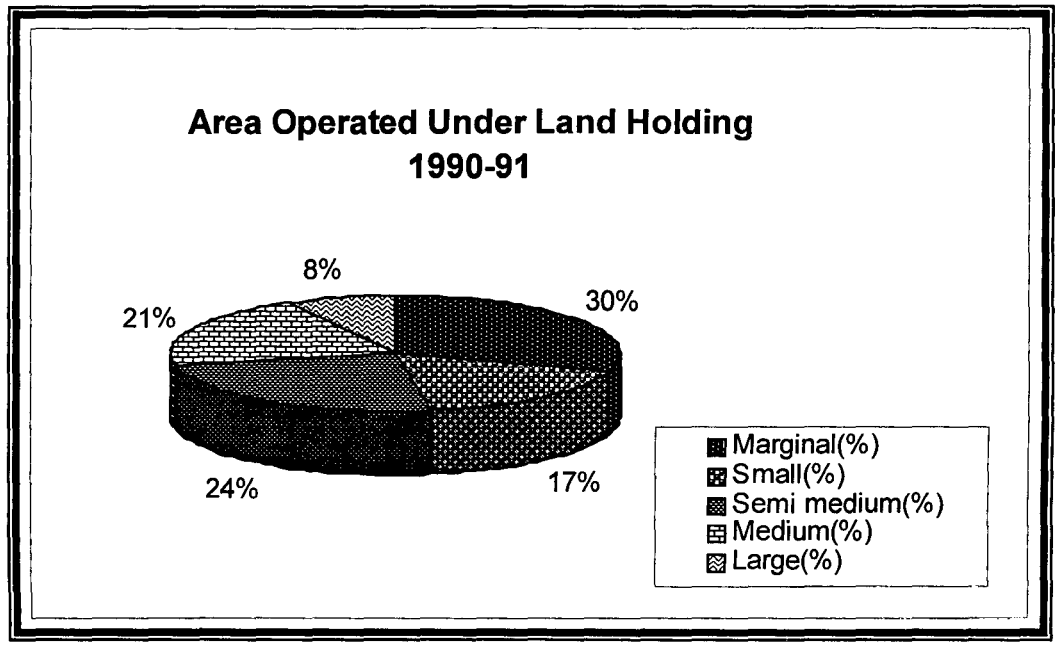
Source: Centre for Monitoring Indian Economy, Agriculture, 1998-99

Table shown that average size of marginal, small, semi medium, medium and large operational holding in the state are 0.37, 1.41, 2.73, 5.68 and 16.13 hectares respectively during 1990-91. The overall average size of holding in the state was 0.93 hectares for the same year. Table also shows that number of marginal and small holding have increased during 1980-81 to 1990-91 by 5.34 and 8.95 percent respectively while medium and large holding decreased during this period from 14.40 and 25.53 percent respectively.

Fig. 2.6

Area Operated Under Land Holding In Bihar





The average size of operational holding among the districts in Bihar shows large scale spatial variations. The average size of operational holding in the districts of North Bihar plains, North-Eastern Bihar plains and South Bihar plains were 1.30 hectare during 1985. as compared to the average size of holding in the districts of Chotanagpur hills region and the Chotanagpur plateau region ranges between 1-2.1 hectares. Table shows that average size of holding decreased during 1980-1985 period in the state as well as the districts except Gopalganj and Siwan.

It is evident from the foregoing discussion that there is uneven social distribution of land holdings in Bihar. Its magnitude gets enhanced due to large scale dependence on monsoons. Irrigation is perhaps one of the basic infrastructure of development property has the potentials to minimize the magnitude by increasing area shown more than once. It is particularly significant for smaller holdings.

2.10 Irrigation

In monsoon lands where the rainfall and its distribution show wide fluctuation's irrigation facilities are a must for achieving assured and high level of agricultural production[5].Irrigation facilities provide security of life, they have lessened the cast of famine relief hand have helped to civilize the whole region. In Bihar, its importance is all the more great. Out of a total of 7702543 hectares of net sown area only 2346575 hectares (30.46 percent) are irrigated in the state. Other area depends upon rainfall. Some of the important sources of in the state are canal, wells, tanks and other sources. The following table (2.2) shows area under irrigation by different mean .

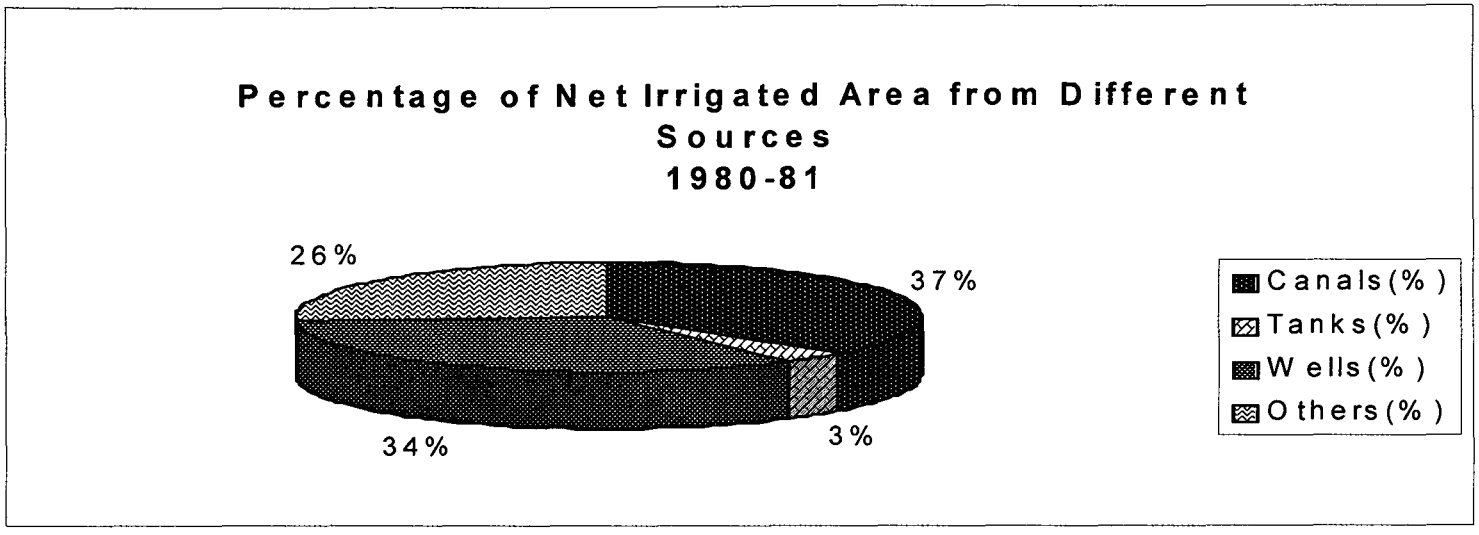
Table 2.2: Percentage of net irrigated area from different sources.

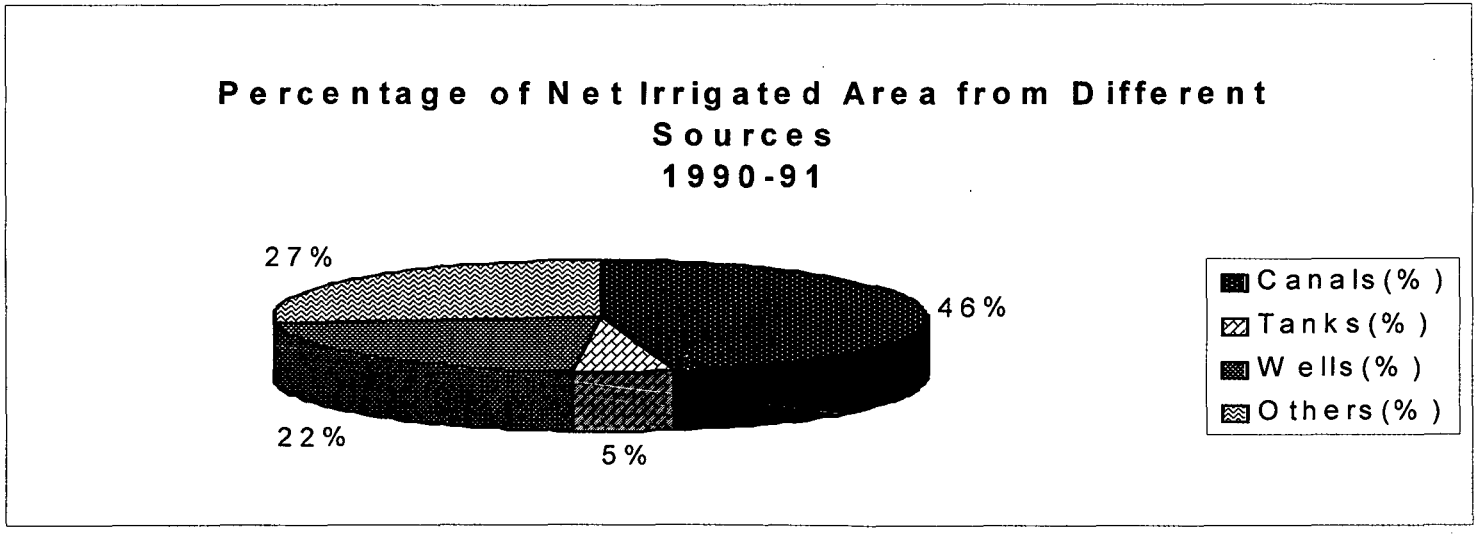
Sources	1980-81	1990-91
i. canals	37.05	46.45
ii.Tanks	3.27	4.90
Ii. Wells	33.72	22.11
iv. other sources	25.96	26.54
	100.00	100.00

Source: Indian Agricultural Statistics 1980-81 and 1990-91

[5] Madan Mohan Batra, " Agricultural Production: Prices and Technology":, Allied Publishers, New Delhi, p. 40.

PERCENTAGE OF NET IRRIGATED AREA FROM DIFFERENT SOURCES IN BIHAR





From the above table it is clear that most of the Irrigation in the state is done through by canals and wells. There was 46.45 percent of total area irrigated through canals during 1990-91 followed by wells and tanks i.e. 22.11 and 4.90 percent respectively During last one decades (1980-81 to 1990-91) irrigation through canals and tanks increased while irrigation through wells have decreased. Canals and wells irrigation are predominant in the plains region while tanks irrigation is in use in the southern plateau region of the state.

Although, Bihar has 30.46 percent net irrigated area , yet it has great variation among different districts in the state. The districts in the South Bihar plains have net irrigated area ranging from 51 to 92 percent and districts in the Chotanagpur hills region and Chotanagpur plateau region it is 1 to 9 percent. The only exception are districts like Palamu (23.31 percent) and Hazaribagh (10.99 percent).

Aurangabad districts has largest irrigated area with 91.32 percent of the net sown area during 1990-91. it was followed by Rohtas, Nawada and Nalanda where irrigated area were 88.35, 88.29 and 88.07 percent respectively. Dhanbad has only 1.26 percent irrigated area followed by Singhbhum (3.44 percent), Ranchi (4.90 percent), Giridih (6.10 percent) etc.

The above discussion shows that Bihar is physiographically diverse in nature comprised of plain and plateau . The plains regions are flood prone and in the plateau regions are drought prone. Plain high population pressure while due to unfavorable relief of the plateau regions population is low. Agriculture is the livelihood of about four fifth population of the state. It shows that its population is mainly rural. The study of land use shows that plateau regions has scarcity of land available for cultivation therefore this region is backward in agriculture. Through due to use of new technology and use of modern agricultural inputs some development has taken place in agriculture particularly in the North Bihar plains. This region is also relatively developed in terms of agricultural infrastructure. This agricultural infrastructure is less developed in the plateau region.

CHAPTER III

REGIONAL DISPARITES IN THE DISTRIBUTION OF AGRICULTURAL INFRASTRUCTURE IN BIHAR

It has been discussed in the previous chapter that there are intra as well as inter regional variations in the state with respect to physiographic, social and economic aspects. These have significantly effected the distribution of agricultural infrastructure in the state. There are variations in the distribution of agricultural infrastructure among the districts. In this chapter attempts have been made to:

i. To study the distribution of availability of agricultural infrastructure at the district level during 1980-81 and 1990-91.
ii. To study the relative development of these infrastructure at district level during 1980-81 and 1990-91.

As discussed in one of the previous chapter nine indicators were selected to study the level of agricultural infrastructure development in Bihar.

3.1 The number of pump sets energise/1000 of net irrigated area (A1)

During 1980-81, Bihar had 54.08 of pumpsets energies/1000 hectares of net irrigated area. As shown in the table no 3.1, Dhanbad district has highest concentration of pumpsets energies/1000 hectares of net irrigated area. It was 422.64 followed by Nalanda (127.03), Patna (105.47), Vaishali (93.42), Nawada (89.25), Hazaribagh (86.88) etc. Champaran (East) shows less concentration of pumpsets energies/1000 hectares of net irrigated area with 6.11. It was followed by Saharsa (6.89), Champaran (West) (7.34), Siwan (10), Gopalganj (13.6), Purnea etc .Out of a total of 31 districts in the state only twelve districts have higher pumpsets energies/1000 hectares than state average. As table 3.1 shows that Champaran (West), Champaran (East), Gopalganj, Siwan, Saran, Madhubani, Darbhanga, Samastipur, Saharsa and Singhbhum has very low concentration of pumpsets energies. It is below 30.29. Sitamarhi, Muzaffarpur, Katihar and Ranchi fall under the range of 30.29-54.47. Begusarai, Rohtas, Aurangabad, Munghyr and Palamu have medium concentration of such pumpsets. It ranges between 54.47-78.66. Vaishali, Gaya, Nawada and Hazaribagh fall under the range of 78.66-102.84. Patna, Nalanda and

Table 3.1 : Indicators of Agricultural Infrastructures in Bihar

DISTRICTS	1980-81	1990-91	Growth 1980-81-1990-91	1980-81	1990-91	Growth 1980-81-1990-91	1980-81	1990-91	Growth 1980-81-1990-91
	pump A 1			trans A 2			elec_vill A 3		
1.Champaran(West)	7.34	19.29	162.81	1.6	3.74	133.75	25.07	62.72	150.18
2.Champaran(East)	6.11	11.08	81.34	1.19	2.91	144.54	32.43	77.1	137.74
3.Gopalganj	13.6	11.86	-12.79	2.13	5.94	178.87	28.85	62.58	116.92
4.Siwan	10	12.64	26.40	1.83	5.21	184.70	27.24	64.33	136.16
5.Saran	23.57	29.46	24.99	2.56	7.96	210.94	37.27	74.35	99.49
6.Sitamarhi	36.91	43.53	17.94	1.95	5.05	158.97	36.7	76.35	108.04
7.Muzaffarpur	48.83	49.68	1.74	1.96	4.52	130.61	40.49	75.34	86.07
8.Vaishali	93.42	80.07	-14.29	3.21	7.77	142.06	43.66	76.74	75.77
9.Madhubani	20.11	31.18	55.05	1.79	3.83	113.97	41.69	93.37	123.96
10.Darbhanga	22.46	67.65	201.20	3.42	7.66	123.98	31.21	78.44	151.33
11.Samastipur	16.15	43.41	168.79	3.01	5.62	86.71	41.81	92.45	121.12
12.Begusarai	74.05	67.67	-8.62	4.87	10.39	113.35	46.47	67.94	46.20
13.Saharsa	6.89	10.31	49.64	1.83	3.47	89.62	31.11	80.18	157.73
14.Purnea	14	16.21	15.79	1.17	2.29	95.73	19.48	50.86	161.09
15.Katihar	43.38	50.2	15.72	1.96	4.1	109.18	13.22	47.29	257.72
16.Bhojpur	29.32	50.07	70.77	2.11	4.42	109.48	31.14	61.07	96.11
17.Rohtas	69.5	102.18	47.02	2.52	5.07	101.19	43.32	65.42	51.02
18.Aurangabad	59.74	69.67	16.62	3.41	5.14	50.73	51.64	90.34	74.94
19.Patna	105.47	190.25	80.38	8.09	14.78	82.69	79.2	92.19	16.40
20.Gaya	81.86	121.34	48.23	4.77	7.76	62.68	57.8	96.34	66.68
21.Nalanda	127.03	176.78	39.16	6.6	11.31	71.36	85.55	96.32	12.59
22.Nawada	89.25	153.21	71.66	6.05	9.22	52.40	63.06	91.72	45.45
23.Munghyr	65.17	84.79	30.11	2.81	6.85	143.77	36.51	56.91	55.88
24.Bhagalpur	28.27	54.27	91.97	2.65	6.37	140.38	20.22	51.24	153.41
25.Hazaribagh	86.88	129.1	48.60	3.69	7.71	108.94	14.58	41.53	184.84
26.Giridih	26	208.9	703.46	2.54	5.5	116.54	7.99	39.64	396.12
27.Santhal Pargana	27.07	119.35	340.89	1.05	5.06	381.90	8.39	34.37	309.65
28.Dhanbad	422.64	1409.47	233.49	9.68	21.47	121.80	23.53	52.54	123.29
29.Palamu	58.7	154.52	163.24	2.29	6.33	176.42	17.48	42.18	141.30
30.Ranchi	39.68	217.67	448.56	0.82	3.19	289.02	16.22	59.39	266.15
31.Singhbhum	17.89	185.77	938.40	1.76	6.25	255.11	6.29	49.08	680.29
Bihar	54.08	110.3		2.65	5.74		27.32	58.49	
Mean	57.14	126.19		3.07	6.69		34.18	68.37	
S.D	75.31	250.21		2.07	3.88		19.26	18.51	
C.V	131.80	198.28		67.47	58.04		56.35	27.07	

Dhanbad have high concentration of the same with above 102.84 pumpsets energies /1000 hectare of net irrigated land.

Table 3.2: Number of Pumpsets energized/1000 hectares of net area irrigated in Bihar

	A_1 *	1980-81	1990-91
Very low	<30.29	Champaran (West), Champaran (East), Gopalganj, Siwan, Saran, Madhubani, Darbhanga, Samastipur, Saharsa, Purnea, Bhojpur, Giridih, Santhal Pargana and Singhbhum.	Champaran (West), Champaran (East), Gopalganj Siwan, Saran, Saharsa and Purnea.
Low	30.29-54.47	Sitamarhi, Muzaffarpur, Katihar and Ranchi.	Sitarmarhi, Muzaffarpur, Madhubani, Samastipur, Katihar, Bhojpur and Bhagalpur.
Medium	54.47-78.66	Begusarai, Rohtas, Aurangabad, Munghyr and Palamu	Darbhanga, Begusarai and Aurangabad.
High	78.66-102.84	Vaishali, Gaya, Nawada and Hazaribagh.	Vaishali, Rohtas and Munghyr.
Very High	>102.84	Patna, Nalanda and Dhanbad..	Patna, Gaya, Nalanda, Nawada, Santhal Pargana, Dhanbad, Palamu, Ranchi, Singhbhum and Hazaribagh.

**No of pumpsets energized /1000 hectares of net area irrigated.*

Source: Electricity Statistics, 1982 & 1992 Bihar Electricity Board, Patna

During 1990-91, number of pumpsets energies/1000 hectares of net area irrigated increased from 54.08 to 110.3 at the state level which shows approximately 104 percent increases during 1980-81 to 1990-91. Dhanbad district shows high concentration of such infrastructural facilities i.e. 1409.47 which is about 233.50 percent increase from 1980-81 to 1990-91. It is followed by Ranchi, Giridih, Patna, and Singhbhum, Nalanda etc. where the increase is 217.67, 208.9, 190.25, 185.77, and 176.78 respectively. Saharsa has very low concentration with 10.31 percent increase followed by Champaran (East) (11.08), Gopalganj (11.86), Siwan (12.64), Purnea (16.21) etc. The districts that show higher growth of such infrastructure facilities during 1980-81 - 1990-91 are Singhbhum (233.50 percent), Santhal Pargana (340.89 percent), Ranchi (448.56percent), Darbhanga (201.20 percent) etc. For Champaran

(West), Champaran (East), Gopalganj, Siwan, Saran, Saharsa and Purnea .It has registered 30.29 pumpsets energies/1000 hectares of net irrigated area. Sitamarhi, Muzaffarpur, Madhubani, Samastipur, Katihar, Bhojpur and Bhagalpur have ranges between 30.29 – 54.47. For Darbhanga, Begusarai and Aurangabad districts it ranges between 54.47 – 78.66 .

It is noticed that the concentration of such facilities in the districts in the plateau regions is higher than the districts in the plain regions. It has been also noted that the growth rate of such facilities during 1980-81 to 1990-91 were higher in plateau region than plain region. Its main reason for being the plateau region has developed in hydro-electricity facilities that are available to run the pumpsets. Lack of power in the other district is the main reason for low ratio of pumpsets /1000 hectares of net irrigated land.

3.2 Number of transformers/1000 hectares of net sown area (A2)

Number of transformers denotes the intensity of consumption of electricity in agriculture sector as well as other sectors. During 1980-81, Bihar as a whole 2.65 transformers/1000 hectares of net sown area. Once again district Dhanbad has higher concentration of this facilities i.e. 9.68. followed by Patna (8.09), Nalanda (6.60), Nawada(6.05) etc. Ranchi has low proportion i.e. 0.82 of the same followed by Santhal Pargana (1.05), Purnea (1.17), Champaran (East) (1.19) etc. As shown in the table 3.3 , Champaran (West), Champaran (East), Gopalganj, Siwan, Saran, Sitamarhi, Muzaffarpur, Madhubani, Saharsa, Purnea, Katihar, Bhojpur, Rohtas, Giridih, Santhal Pargana, Palamu, Ranchi and Singhbhum too have very low number of distribution transformers/1000 hectares of net sown area i.e. below 2.59. The value for districts like Vaishali, Darbhanga, Samastipur, Aurangabad, Munghyr, Bhagalpur and Hazaribagh districts ranges between 2.59 – 4.36.

On the basis of the table it can be said that number of transformers /1000 hectares of net sown area is high in district from plains with the exception of Dhanbad.

Table3.3: Number of distribution transformers/1000 hectares net sown area in Bihar .

	A2 *	1980-81	1990-91
Very low	2.597	Champaran (West), Champaran(East), Gopalganj, Siwan, Saran, Sitamarhi, Muzaffarpur, Madhubani, Saharsa, Purnea, Katihar, Bhojpur, Rohtas, Giridih, Santhal Pargana, Palamu, Ranchi and Singhbhum	Purnea
Low	2.59-4.36	Vaishali, Darbhanga, Samastipur, Aurangabad, Munghyr, Bhagalpur and Hazaribagh	Champaran (West), Champaran (East), Madhubani, Saharsa, Katihar and Ranchi
Medium	4.36-6.13	Begusarai, Gaya and Nalanda	Gopalganj, Siwan, Sitamarhi, Muzaffarpur, Samastipur, Bhojpur, Rohtas, Aurangabad, Giridih and Santhal Pargana
High	6.13 – 7.90	Nalanda	Vaishali, Darbhanga, Gaya, Munghyr, Bhagalpur, Hazaribagh, Palamu and Singhbhum
Very High	77.90	Patna and Dhanbad	Begusarai, Patna, Nalanda, Nawada and Dhanbad

** No of distribution transformers /1000 hectares net sown area.*

Source: Electricity Statistics 1982 & 1992 Bihar Electricity Board, Patna.

The above table shows that majority of the districts had low ratio of transformers in 1981 and there were only three districts that have recorded high concentration. As compared to this the situation have changed from 1981 to 1991 and in 1991 only one district have very low ratio while there were more than 13 districts that have recorded high value.

Thus it can be said that over the years the situation seems to have improved in the districts situated in the Ganga plains.

3.3 The percentage of village electrified (A3)

The rural infrastructure is very important for agriculture development .It is particularly for providing lift irrigation. During 1980-81, there were 27.32 percent of the total villages electrified in the state. Nalanda district had more than 85.55 percent villages electrified followed by Patna (79.20 percent), Nawada (63.06 percent), Gaya (57.80 percent), Aurangabad (51.64 percent) etc. Singhbhum has lowest electrified village i.e. 6.29 percent followed by Giridih (7.99 percent), Hazaribagh (14.58 percent) etc. As table 3.4 shows, Purnea, Katihar, Bhagalpur, Hazaribagh, Giridih, Santhal Pargana, Palamu, Ranchi, and Singhbhum districts has very low percentage of electrified village i.e. below 22.14 percent .Champaran (West), Champaran(East), Gopalganj, Munghyr and Dhanbad had electrified villages ranging between 22.14 – 37.99 percent. Muzaffarpur, Vaishali, Madhubani, Samastipur, Begusarai, Rohtas and Aurangabad has medium ranges of electrified villages i.e. 37.99 – 53.84 percent.

Table3.4: Percentage of village electrified in Bihar

	A3*	1980-81	1990-91
Very low	<22.14	Purnea, Katihar, Bhagalpur, Hazaribagh, Giridih, Santhal Pargana, Palamu, Ranchi, Singhbhum	
Low	22.14-37.99	Champaran(West), Champaran(East), Gopalganj, Siwan, Saran, Sitamarhi, Darbhanga, Saharsa, Bhojpur, Munghyr and Dhanbad	Santhal Pargana
Medium	37.99-53.84	Muzaffarpur, Vaishali, Madhubani, Samastipur, Begusarai, Rohtas and Aurangabad	Purnea, Katihar, Bhagalpur, Hazaribagh, Giridih, Dhanbad, Palamu and Singhbhum
High	53.84-69.69	Gaya and Nawada	Champaran (West), Gopalganj, Siwan, Begusarai, Bhojpur, Rohtas, Munghyr and Ranchi
Very High	>69.69	Patna and Nalanda	Champaran (East), Saran, Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur, Saharsa, Aurangabad, Patna, Gaya, Nalanda and Nawada

**Percentage of villages electrified.*

Source: Electricity Statistics, 1982 & 1992 Bihar Electricity Board, Patna.

Table 3.2 : Indicators of Agricultural Infrastructures in Bihar

DISTRICTS	1980-81 bank offices A 4	1990-91	Growth 1980-81-1990-91	1980-81 credit_rs A 5	1990-91	Growth 1980-81-1990-91	1980-81 credit_wor A 6	1990-91	Growth 1980-81-1990-91
1.Champaran(West)	2.02	4.81	138.12	79.82	1246.16	1461.21	54.78	652.53	1091.18
2.Champaran(East)	2.63	4.63	76.05	42.83	1410.69	3193.70	27.57	700.74	2441.68
3.Gopalganj	1.16	4.79	312.93	31.13	519.77	1569.68	21.25	385.73	1715.20
4.Siwan	1.17	5.01	328.21	67.16	620.96	824.60	49.42	416.46	742.70
5.Saran	1.56	4.4	182.05	72.34	1749.91	2319.01	49.93	926.2	1755.00
6.Sitamarhi	1.46	4.16	184.93	51.24	714.65	1294.71	31.13	312.51	903.89
7.Muzaffarpur	1.47	4.81	227.21	108.83	778.79	615.60	64.93	394.2	507.12
8.Vaishali	1.8	0.24	-86.67	69.9	968.1	1284.98	37.16	408.02	998.01
9.Madhubani	2.84	4.28	50.70	7.51	848	11191.61	4.52	356.76	7792.92
10.Darbhanga	1.41	4.62	227.66	49.34	977.32	1880.79	26.55	406.24	1430.09
11.Samastipur	1.28	4.64	262.50	48.01	1018.23	2020.87	26.92	494.09	1735.40
12.Begusarai	1.07	4.27	299.07	34.83	1260.24	3518.26	21.03	639.71	2941.89
13.Saharsa	1.04	4.4	323.08	34.93	517.18	1380.62	19.5	259.61	1231.33
14.Purnea	1.42	3.79	166.90	61.97	539.54	770.65	43.69	294.77	574.69
15.Katihar	1.62	4.35	168.52	27.38	823.87	2909.02	19.28	428.54	2122.72
16.Bhojpur	2.23	5.09	128.25	19.05	735.88	3762.89	17.85	573.45	3112.61
17.Rohtas	2.2	5.29	140.45	43.67	719.61	1547.84	49.98	652.4	1205.32
18.Aurangabad	1.56	5.13	228.85	5.64	692.93	12185.99	5.66	518.15	9054.59
19.Patna	1.58	5.48	246.84	463.2	2520.44	444.14	297.14	1191.02	300.83
20.Gaya	1.28	5.07	296.09	29.74	670.69	2155.18	15.61	303.01	1841.13
21.Nalanda	2.18	4.93	126.15	86.06	1090.95	1167.66	51.21	560.88	995.25
22.Nawada	3.11	4.58	47.27	33.61	664.3	1876.50	22.4	319.43	1326.03
23.Munghyr	1.5	3.96	164.00	40.98	965.16	2255.20	25.42	400.09	1473.92
24.Bhagalpur	1.51	4.79	217.22	60.46	1349.69	2132.37	37.98	550.43	1349.26
25.Hazaribagh	1.98	5.27	166.16	16.09	1485.07	9129.77	8.52	559.89	6471.48
26.Giridih	1.88	6.06	222.34	4.93	1178.17	23797.97	2.39	371.05	15425.10
27.Santhal Pargana	2.62	6.13	133.97	10.43	671.11	6334.42	7.42	260.14	3405.93
28.Dhanbad	2.11	5.67	168.72	40.74	1731.21	4149.41	20.19	598.93	2866.47
29.Palamu	1.65	5.21	215.76	16.75	911.82	5343.70	8.71	347.29	3887.26
30.Ranchi	2.1	5.77	174.76	27.33	690.09	2425.03	28.38	469.13	1553.03
31.Singhbhum	1.74	7	302.30	11.83	595.07	4930.18	8.35	291.02	3385.27
Bihar	1.78	4.91		51.87	905.67		35.24	459.25	
Mean	1.78	4.72		54.77	1002.35		35.64	491.71	
S.D	0.53	1.02		79.99	446.67		51.31	201.53	
C.V	29.52	21.70		146.06	44.56		143.96	40.98	

From the above table it can be inferred that majority of the village were included in the low and very low categories with below 38 per cent of the total village electrified in 1981.As compared to this the number of villages included in the high average category of electrified village have increased in 1991.There were as many as 22 districts that had more than 34 percent of the total villages in 1991 while the number of such districts was only four in 1981.There was an increase of over 114.09 percent from 1981 to 1991 as far as total number of electrified village in the state are concerned .

3.4 **Offices of Scheduled Commercial Banks (SCBs) in Rural area/lakh rural population (A4)**

From the experience of developed agricultural region it has become clear that availability of credit is a must for agricultural development .Credit is needed to purchase modern non farm inputs .In this regard Bank and other financial institution have an important role to play. It is also true about Bihar.

During 1980-81, there were 1.78 offices of scheduled commercial Banks to per lakh population at the state level. It is also shown in the table3.5 that Patna district has highest ratio offices of SCBs/lakh rural population i.e. 3.11. It is followed by Madhubani (2.84), Champaran (East) (2.63), Santhal Pargana (2.62) etc. Saharsa has lowest number of SCBs/lakh rural population i.e. 1.04. It has been followed by Begusarai (1.07), Gopalganj (1.16), Siwan (1.17) etc.

This table also shows that Gopalganj, Siwan, Darbhanga, Samastipur, Begusarai, Saharsa, Purnea and Gaya districts have less than 1.45 bank offices of SCBs/ lakh rural population. Saran, Sitamarhi, Muzaffarpur, Vaishali, Katihar, Aurangabad, Patna, Munghyr, Bhagalpur, Palamu and Singhbhum have the ratio for the same ranging between 1.45-1.86. Champaran (West), Bhojpur, Rohtas, Nalanda, Hazaribagh, Giridih, Dhanbad and Ranchi account for the value between 1.86-2.28 per lakh of rural population.

Table 3.6: Offices of Scheduled Commercial Banks in rural areas/Lakh rural population in Bihar

	A4*	1980-81		1990-91
Very low	<1.45	Gopalganj, Siwan, Darbhanga, Samastipur, Begusarai, Saharsa, Purnea and Gaya	<4.43	Saran, Sitamarhi, Vaishali, Madhubani, Begusarai, Saharsa, Purnea, Katihar and Munghyr
Low	1.45-1.86	Saran, Sitamarhi, Muzaffarpur, Vaishali, Katihar, Aurangabad, Patna, Munghyr, Bhagalpur, Palamu and Singhbhum	4.43-5.07	Champaran (West), Champaran (East), Gopalganj, Siwan, Muzaffarpur, Darbhanga, Samastipur, Nalanda, Nawada and Bhagalpur.
Medium	1.86-2.28	Champaran (west), Bhojpur, Rohtas, Nalanda, Hazaribagh, Giridih, Dhanbad and Ranchi	5.07-5.71	Bhojpur, Rohtas, Patna, Gaya, Hazaribagh, Dhanbad, Palamu and Aurangabad
High	2.28-2.69	Champaran (East) and Santhal Pargana	5.71-6.35	Giridih, Santhal Pargana and Ranchi
Very High	>2.69	Madhubani and Nawada	>6.35	Singhbhum.

**Offices of scheduled commercial banks in rural areas /lakh rural population*

Source: Banking statistics, 1980-81 & 1990-91 Reserve Bank of India.

Unlike other infrastructure attributes the ratio of scheduled bank offices to per lakh population have a quantum jump from 1981 to 1991.The value for the lowest and the highest range between below 1.45 to more than 2.49 bank offices per lakh of rural population in 1991.This have changed to below 4.43 and above 6.35 for the lowest and highest districts represented in 1991.There was approximately an increase of 176 per cent in these 10 years. It is also worth noting that numbers of districts in each category were more or less even.

3.5 Availability of outstanding agriculture credit (Rs.) per hectare of gross sown area (A5)

There were Rs 51.87 outstanding agricultural credits per hectare of gross sown area available in the state during 1980-81. As shown in the table 3.5, Patna district has high availability of outstanding agricultural credit per hectare of gross sown area i.e.Rs 463.20. It was followed by Muzaffarpur (Rs108.83), Nalanda (Rs 86.06), Champaran (West) (Rs79.82) districts etc. Giridih had only Rs 4.93 available as

outstanding agricultural credit per hectare of gross sown area followed by Aurangabad (Rs5.64), Madhubani (Rs7.51), Santhal Pargana (Rs10.43) etc. There were high disparities in the availability of such infrastructure between the developed and backward districts. For example it was Rs4.93 for Giridih and Rs 463.2 for Patna.

From the table it is evident that though there has been an increase in the availability of bank credit from 1981 to 1991 .For example the more well of district of Patna and Muzaffarpur have Rs 88.29 available towards agricultural credit in 1981 and it increased to Rs917 in case of the least developed in 1991, it was as high as Rs2119 for Patna, the most developed district in 1991.But what is surprising is note that the number of districts were ten in the low category in 1981 as compared to 1991.There were 8 districts that have recorded relatively low value in 1981.But the number of such districts increased up to 18 in 1991.This means that inter disparities have increased as far as availability of agricultural credit was concerned.

Table3.7: Outstanding agricultural credit (Rs.)/hectare gross sown area

	A5*	1980-81	A5*	1990-91
Very low	<25.77	Madhubani, Bhojpur, Aurangabad, Hazaribagh, Giridih, Santhal Pargana, Palamu and Singhbhum	<917.83	Gopalganj, Siwan, Sitamarhi, Muzaffarpur, Madhubani, Saharsa, Purnea, Katihar, Bhojpur, Rohtas, Aurangabad, Gaya, Nawada, Santhal Pargana, Palamu, Ranchi and Singhbhum
Low	25.77-46.61	Champaran (East), Gopalganj, Begusarai, Saharsa, Katihar, Rohtas, Gaya, Nawada, Munghyr , Dhanbad and Ranchi	917.83-1318.48	Champaran (West), Vaishali, Darbhanga, Samastipur, Begusarai, Katihar, Nalanda and Giridih
Medium	46.61-67.45	Siwan, Sitamarhi, Darbhanga, Samastipur, Purnea and Bhagalpur	1318.48-1719.13	Champaran (East), Bhagalpur and Hazaribagh
High	67.45-88.29	Champaran(West), Siwan, Vaishali and Nalanda	1719.13-2119.78	Saran and Dhanbad
Very High	>88.29	Muzaffarpur and Patna	>2119.78	Patna

**Outstanding agricultural credit (Rs)/hectare gross sown area.*

Source: Banking statistic, 1980-81 & 1990-91 Reserve Bank of India.

3.6 Availability **of outstanding agriculture credit (Rs.) per agricultural worker in Bihar (A6)**

During 1980-81, the availability of outstanding agricultural credit per agricultural worker in the state was Rs35.24. Patna district had shown highest availability of such credit will Rs 297.14 followed by Muzaffarpur (Rs64.93), Champaran (West) (Rs54.78), Nalanda (Rs51.21) districts etc. Giridih has been lowest availability of such credit which is only Rs2.39 .These were followed by Madhubani (Rs 4.52), Aurangabad (Rs5.66), Santhal Pargana districts etc. As table 3.5 shows once again there were very large disparities between Patna and Giridih districts as far as availability of such credit is concerned. It was as high as Rs 297.14 for Patna and only Rs 2.39 for Giridih.

As shown in the table 3.8, Madhubani, Aurangabad, Hazaribagh, Giridih, Santhal Pargana, Palamu and Singhbhum district have very low availability of such credit i.e. below Rs14.89. Availability of such credit in Gopalganj, Darbhanga, Samastipur, Begusarai, Saharsa, Katihar, Bhojpur, Gaya, Nawada, Munghyr and Dhanbad districts ranges between Rs14.89- 27.40 and for Champaran (East), Sitamarhi, Vaishali, Bhagalpur and Ranchi districts it was ranging between Rs 27.40 – 39.91 .

Table 3.4 : Indicators of Agricultural Infrastructures in Bihar

DISTRICTS	1980-81	1990-91	Growth 1980-81-1990-91	1980-81	1990-91	Growth 1980-81-1990-91	1980-81	1990-91	Growth 1980-81-1990-91
	Fer_Con A 7			GIA_GSA A 8			Trac_GSA A 9		
1.Champaran(West)	18.02	87.71	386.74	41.33	33.97	-17.81	3.78	8.03	112.43
2.Champaran(East)	24.74	61.16	147.21	26.47	38.26	44.54	1.87	15.16	710.70
3.Gopalganj	47.97	95.11	98.27	44.47	45.13	1.48	2.4	1.45	-39.58
4.Siwan	23.28	57.76	148.11	41.8	46.89	12.18	1.7	1.41	-17.06
5.Saran	32.81	95.78	191.92	38	42.66	12.26	0.98	12.37	1162.24
6.Sitamarhi	13.79	110.82	703.63	11.77	19.63	66.78	0.89	0.11	-87.64
7.Muzaffarpur	32.48	60.39	85.93	21.83	27.72	26.98	1.15	16.05	1295.65
8.Vaishali	19.59	109.14	457.12	24.11	39.37	63.29	0.75	0.55	-26.67
9.Madhubani	6.9	45.01	552.32	12.68	20.31	60.17	0.29	2.59	793.10
10.Darbhanga	10.87	60.18	453.63	13.68	30.24	121.05	0.67	5.76	759.70
11.Samastipur	25.93	110.33	325.49	27.25	36.03	32.22	1.1	2.69	144.55
12.Begusarai	31.04	146.85	373.10	28.57	45.33	58.66	2.17	14.15	552.07
13.Saharsa	8.21	42.36	415.96	27.76	38.68	39.34	1.49	3.36	125.50
14.Purnea	7.8	82.02	951.54	14.63	26.23	79.29	1.53	9.02	489.54
15.Katihar	5.76	63.29	998.78	19.26	32.16	66.98	1.42	1.03	-27.46
16.Bhojpur	36.22	102.53	183.08	68.8	97.9	42.30	1.85	10.21	451.89
17.Rohtas	31.24	116.11	271.67	72.8	82.22	12.94	3.58	8.56	139.11
18.Aurangabad	12.89	79.92	520.02	65.09	72.4	11.23	1.3	1.59	22.31
19.Patna	38.15	157.27	312.24	59.91	63.87	6.61	2.61	17.59	573.95
20.Gaya	38.72	66.39	71.46	83.49	79.66	-4.59	1.11	2.52	127.03
21.Nalanda	40.3	135.81	237.00	82.24	78.8	-4.18	1.39	6.42	361.87
22.Nawada	18.92	99.02	423.36	74.53	78.74	5.65	0.69	0.37	-46.38
23.Munghyr	17.73	79.27	347.10	35.8	47.3	32.12	1.59	5.29	232.70
24.Bhagalpur	25.82	88.94	244.46	40.78	49.31	20.92	1.13	12.78	1030.97
25.Hazaribagh	5.11	14.6	185.71	9.56	13.15	37.55	0.34	2.35	591.18
26.Giridih	4.47	18.19	306.94	8.3	7.48	-9.88	0.15	3.08	1953.33
27.Santhal Pargana	6.04	21.46	255.30	9.99	7.52	-24.72	0.07	0.73	942.86
28.Dhanbad	3.71	5.25	41.51	2.96	1.51	-48.99	0.1	6.14	6040.00
29.Palamu	4.91	16.49	235.85	22.15	25.59	15.53	0.74	2.23	201.35
30.Ranchi	6	38.2	536.67	5.58	5.1	-8.60	0.37	1.05	183.78
31.Singhbhum	3.15	20.31	544.76	4.22	3.83	-9.24	0.04	0.91	2175.00
Bihar	18.35	72.13		32.58	39.98		1.31	5.7	
Mean	19.44	75.58		33.54	41.11		1.27	5.82	
S.D	13.26	39.87		24.54	25.36		0.94	5.32	
C.V	68.21	52.76		73.15	61.68		74.14	91.43	

Table3.8: Outstanding agricultural credit (Rs.)/agricultural worker

	A6*	1980-81	A6*	1990-91
Very low	<14.89	Madhubani, Aurangabad, Hazaribagh, Giridih, Santhal Pargana, Palamu and Singhbhum	<445.89	Gopalganj, Siwan, Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Saharsa, Purnea, Katihar, Gaya, Nawada, Munghyr, Giridih, Santhal Pargana, Palamu and Singhbhum.
Low	14.89-27.40	Gopalganj, Darbhanga, Samastipur, Begusarai, Saharsa, Katihar, Bhojpur, Gaya, Nawada, Munghyr and Dhanbad	445.89-632.17	Samastipur, Bhojpur, Aurangabad, Nalanda, Bhagalpur, Hazaribagh, Dhanbad and Ranchi
Medium	27.40-39.91	Champaran (East), Sitamarhi, Vaishali, Bhagalpur and Ranchi	632.17-818.45	Champaran (West), Champaran (East), Begusarai and Rohtas
High	39.91-52.42	Siwan, Saran, Purnea, Rohtas and Nalanda	818.45-1004.73	Saran
Very High	>52.42	Champaran (West), Muzaffarpur and Patna	>1004.73	Patna

**Outstanding agricultural credit (Rs)/agricultural workers.*

Source: Banking Statistics, 1980-81 and1991 Reserve bank of India.

During 1990-91, availability of outstanding agricultural credit per agricultural workers was Rs459.25 at the state level. It recorded growth rate of 1203.20 percent during 1980-81 to 1990-91.

As shown in the table 3.5, Patna has highest availability of such credit in the state with Rs1191.02 followed by Saran (Rs926.20) Champaran (East) (Rs700.74.), Champaran (West) (Rs652.53) Rohtas (Rs652.40) districts etc.

As shown in the table 3.8 Gopalganj, Siwan, Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Munghyr, Santhal Pargana , Palamu and Singhbhum districts has very low availability of such credit These have recorded Rs445.89.

3.7 Fertilizers **consumption (Kgs.) per hectares of gross sown area (GSA) (A7)**

The fertilizer plays an important role in the agricultural development because it provides nutrients to the soil for production of crops which denotes the intensity of agricultural development.

As shown in the table 3.9, fertilizers consumption per hectares of gross sown area in the state during 1980-81 was 18.35 Kgs. There was a large variation in the consumption of fertilizers among the districts. Gopalganj district had higher consumption of fertilizers in the state with 47.97 Kgs per hectares of gross sown area. It was been followed by Nalanda (40.30Kgs), Gaya, (38.72Kgs), Patna (38.15 Kgs) districts etc. Lowest consumption of fertilizers was found in Singhbhum district i.e. only 3.15 kgs per hectares of gross sown area

As shown in the table 3.10, fertilizers consumption per hectares of gross sown area was below 12.11 kgs in Madhubani, Darbhanga, Saharsa, Purnea, Katihar, Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Palamu, Ranchi and Singhbhum. For Champaran (west), Sitamarhi, Vaishali, Aurangabad, Nawada and Munghyr consumption of fertilizers ranges between 12.11 – 21.07 kgs per hectare.

Table 3.10: Fertilizers consumption (Kgs.)/ hectares gross sown area in Bihar.

	A7*	1980-81	A7*	1990-91
Very low	<12.11	Madhubani, Darbhanga, Saharsa, Purnea, Katihar, Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Palamu, Ranchi and Singhbhum	<35.65	Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Palamu and Singhbhum
Low	12.11-21.07	Champaran (west), Sitarmarhi, Vaishali, Aurangabad, Nawada and Munghyr	35.65-66.05	Champaran(East), Siwan, Muzaffarpur, Madhubani, Darbhanga, Saharsa, Katihar and Ranchi
Medium	21.07-30.04	Champaran (East), Siwan, Samastipur and Bhagalpur	66.05-96.46	Champaran (West), Gopalganj, Saran, Purnea, Aurangabad, Gaya, Munghyr and Bhagalpur
High	30.04-39.00	Saran, Muzaffarpur, Begusarai, Bhojpur, Rohtas, Patna and Gaya	96.46-126.86	Sitamarhi, Vaishali, Samatsipur, Bhojpur, Rohtas and Nawada
Very High	>39.00	Gopalganj and Nalanda	>126.86	Begusarai, Patna and Nalanda

**Fertilizer consumption (kg)/hectare gross sown area.*
Source: Fertilizer statistics, The Fertilizer association of India, New Delhi.

During 1990-91, the consumption of fertilizer per hectares in the state increased upto 72.13 Kgs with the growth rate of 293.08 percent over 1980-81. Patna district has highest consumption of fertilizers during 1990-91 i.e. 157.27 Kgs per hectares. It was followed by Begusarai (146.85 Kgs), Nalanda (135.81 kgs), Rohtas (116.11kgs) districts etc. Dhanbad district shows low consumption of fertilizers i.e. only 5.25 Kgs per hectares of GSA. It was followed by Hazaribagh (14.6 kgs), Giridih (18.19 kgs), Singhbhum (20.31 kgs) districts etc.

As shown in table 3.10 consumption of fertilizers was below 35.65 kg in Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Palamu and Singhbhum districts. While it ranged between 35.65 -66.05 kgs Champaran (East), Siwan, Muzaffarpur, Madhubani, Darbhanga, Saharsa, Katihar and Ranchi districts.

3.8 Gross area irrigated as percentage of gross sown area (GSA) (A8)

Irrigation is one of the most important infrastructure for agricultural development. It provides a sure supply of water for most of the agricultural practices.. There have been variations found in the distribution of such facilities among the districts of the state.

As shown in the table 3.9, there was 33.54 percent of gross sown area identified as area under irrigation in 1980-81 for the state as a whole. However it varied from districts to districts. Gaya district had highest gross irrigated area as percentage of GSA with. 83.49 percent. It was followed by Nalanda (82.24 percent), Nawada (74.53 percent). Rohtas (72.80 percent) districts etc. Dhanbad district had very low gross irrigated area with only 2.96 percent followed by Singhbhum (4.22 percent), Ranchi (5.58 percent), Giridih (8.30 percent) districts etc.

Table 3.11 shows that Sitamarhi, Madhubani, Darbhanga, Purnea, Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Ranchi and Singhbhum have very low percentage of such infrastructure facilities i.e. below 19.06 percent.

Table3.11: Gross area irrigated as percentage of gross sown area in Bihar

	A8*	1980-81	1990-91
Very low	<19.06	Sitamarhi, Madhubani, Darbhanga, Purnea, Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Ranchi and Singhbhum	Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Ranchi and Singhbhum.
Low	19.06-35.17	Champaran(East), Muzaffarpur, Vaishali, Samastipur, Begusarai, Saharsa, Katihar and Palamu	Champaran(West), Sitamarhi, Muzaffarpur, Madhubani, Darbhanga, Purnea, Katihar and Palamu
Medium	35.17-51.27	Champaran(west), Gopalganj, Siwan, Saran, Munghyr and Bhagalpur	Champaran(East), Gopalganj, Siwan, Saran, Vaishali, Samastipur, Begusarai, Saharsa and Munghyr
High	51.27-67.38	Patna and Aurangabad	Patna
Very High	>67.38	Bhojpur, Rohtas, Gaya, Nalanda and Nawada	Bhojpur, Rohtas, Aurangabad, Gaya, Nalanda and Nawada

**Gross area irrigated as percentage of gross sown area.*

Source :Indian agricultural statistics, 1980-81 & 1990-91 Directorate of Economic and Statistics, Department of Agriculture ,New Delhi.

Coming to 1990-91, the percentage of gross area irrigated area increased upto 39.98 percent in the state .It was approximately 22.71 percent growth during 1980-81 to 1990-91. As shown in the table gross irrigated area decreased from 41.33 to 33.97 percent in west Champaran district .Dhanbad, Ranchi and Singhbhum has also shown decreasing percentage of irrigated area during 1980-81 – 1990-91 period.

It is also shown in the table 3.11 that the percentage of gross irrigated area in Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Ranchi and Singhbhum was very low i.e. below 19.06 percent. It ranged between 19.06-35.17 percent in Champaran (West), Sitamarhi, Muzaffarpur, Madhubani, Darbhanga, Purnea, Katihar and Palamu. The percentage of such irrigated area in Champaran (East), Gopalganj, Siwan, Saran, Vaishali, Samastipur, Begusarai, Saharsa, Munghyr and Bhagalpur district ranged between 35.17-51.27 percent.

3.9. Tractors per 1000 hectares of gross sown area (GSA) (A9)

Tractors are modern technical inputs in the agricultural sector which has multipurpose uses like tilling as well as means of transportation for transporting agricultural output to the market.

As shown in the table 3.12, there were 1.31 tractors per 1000 hectares of gross sown area in the state during 1980-81. However, there were inter-district variations .Madhubani, Darbhanga, Nawada, Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Palamu, Ranchi and Singhbhum had 0.78 tractors per 1000 hectares of gross sown area. The number of this infrastructure in Saran, Sitamarhi, Muzaffarpur, Samastipur, Saharsa, Katihar, Aurangabad, Gaya, Nalanda and Bhagalpur ranged between 0.78-1.53. In case of Champaran (East), Siwan, Begusarai, Purnea, Bhojpur and Munghyr the number of tractors ranged between 1.53 – 2.28. Champaran (West) had high availability of this infrastructure which was 3.78 per 1000 hectares of GSA. It was followed by Rohtas (3.58), Patna (2.61), Gopalganj (2.40) districts etc. At the other extreme there was Singhbhum with low availability of such infrastructure facilities i.e. only 0.04 followed by Santhal Pargana, (0.07), Dhanbad (0.10), Giridih (0.15) districts etc.

Table 3.12: Tractor per '000 hectares of gross sown area

	A9*	1980-81	A9*	1990-91
Very low	<0.78	Vaishali, Madhubani, Darbhanga, Nawada, Hazaribagh, Giridih, Santhal Pargana, Dhanbad, Palamu, Ranchi and Singhbhum	<3.60	Gopalganj, Siwan, Sitamarhi, Vaishali, Madhubani, Samastipur, Saharsa, Katihar, Aurangabad, Gaya, Nawada, Hazaribagh, Giridih, Santhal Pargana, Palamu, Ranchi and Singhbhum
Low	0.78-1.53	Saran ,Sitamarhi, Muzaffarpur, Samastipur ,Saharsa, Katihar, Aurangabad, Gaya, Nalanda and Bhagalpur	3.60-7.10	Darbhanga, Nalanda, Munghyr and Dhanbad
Medium	1.53-2.28	Champaran(East), Siwan, Begusarai, Purnea, Bhojpur and Munghyr	7.10-10.59	Champaran (West), Purnea, Bhojpur and Rohtas
High	2.28-3.03	Gopalganj and Patna	10.59-14.09	Saran and Bhagalpur
Very High	>3.03	Champaran(West) and Rohtas	>14.09	Champaran (East), Muzaffarpur, Begusarai and Patna

**Tractors per thousand hectare of gross sown area.*

Source: Bihar statistical handbook, 1982 and state transports corporation 1991.

During 1990-91, the number of tractors per 1000 hectares of GSA increased upto 5.70 .It recorded 335.11 percent growth rate during 1980-81 to 1990-91. Large scale disparities have been found in the distribution of such infrastructure among the districts of the state. Gopalganj, Siwan, Sitamarhi, Vaishali, Madhubani, Samastipur, Saharsa, Katihar, Aurangabad, Gaya, Nawada, Hazaribagh, Giridih, Santhal Pargana, Palamu, Ranchi and Singhbhum had low availability of this infrastructure which was 3.60. The value of tractor per thousand hectare of G.S.A was between 3.60-7.10 for Darbhanga, Nalanda, Munghyr and Dhanbad. District Patna was most developed in this regard it had more than 17 tractor per thousand hectare of G.S.A. followed by Muzaffarpur (16.05), Champaran (East) (15.16), Begusarai (14.15) Bhagalpur (12.78), Saran (12.37) districts etc. The lowest such infrastructure has been found in Sitamarhi (0.11) followed by Nawada (0.37) districts etc.

It is also noticed that availability of tractors was very low in the plateau region and it was high in Ganga plains.

It can be summarized from the above discussion that there are large inter district variations in the availability of infrastructure in Bihar. In this section relative positions of districts have been worked out in relation to all the indicators. For this purpose composite index for agricultural infrastructure have been calculated. Principal component analysis method was used to find out the composite index.

Composite Index of Agricultural Infrastructure

Composite Index for the entire agricultural infrastructure have been calculated to show the concentration of such facilities among the districts in the state for 1980-81 and 1990-91.

During 1980-81, as shown in the table Patna district has high concentration of agricultural infrastructure and it secured rank 1. It was followed by Nalanda, Gaya, Rohtas, Nawada districts etc which has been secure 2^{nd}, 3^{rd}, 4^{th}, 5^{th} rank respectively while Singhbhum district has very low concentration of agricultural infrastructure and secured last position among the districts of the state with rank 31^{st}. It has been

Table 3.4 : Index of Agricultural Infrastructure in Bihar

DISTRICTS	1980-81		1990-91	
	PCA	Rank	PCA	Rank
1.Champaran(West)	0.32	9	0.32	10
2.Champaran(East)	-0.19	19	0.74	5
3.Gopalganj	0.45	7	-0.50	20
4.Siwan	0.10	13	-0.63	23
5.Saran	0.27	11	1.53	2
6.Sitamarhi	-0.40	20	-0.52	21
7.Muzaffarpur	0.34	8	0.02	15
8.Vaishali	0.03	15	0.17	12
9.Madhubani	-0.85	26	-0.56	22
10.Darbhanga	-0.44	22	-0.11	17
11.Samastipur	0.05	14	0.23	11
12.Begusarai	0.51	6	1.32	3
13.Saharsa	-0.42	21	-0.86	26
14.Purnea	-0.56	23	-0.69	24
15.Katihar	-0.75	24	-0.74	25
16.Bhojpur	0.30	10	0.52	9
17.Rohtas	0.94	4	0.59	7
18.Aurangabad	0.15	12	0.05	14
19.Patna	3.74	1	3.40	1
20.Gaya	0.96	3	-0.07	16
21.Nalanda	1.74	2	1.20	4
22.Nawada	0.62	5	0.08	13
23.Munghyr	0.00	16	-0.12	18
24.Bhagalpur	-0.05	17	0.56	8
25.Hazaribagh	-0.92	27	-0.46	19
26.Giridih	-1.23	29	-1.00	27
27.Santhal Pargana	-1.32	30	-1.57	31
28.Dhanbad	-0.11	18	0.60	6
29.Palamu	-0.84	25	-1.01	28
30.Ranchi	-1.07	28	-1.04	29
31.Singhbhum	-1.34	31	-1.45	30

followed by Santhal Pargana, Giridih, Ranchi, Hazaribagh, Madhubani districts etc. with rank of 30th, 29th, 28th , 27th , 26th respectively..

Other districts like Begusarai (6), Gopalganj (7), Muzaffarpur (8), Champaran (West) (9), Bhojpur (10) have also shown high concentration of agricultural infrastructure.

It has been noted here that concentration of agricultural infrastructure in the districts of plateau region is very low in respect to the districts of the north and south Bihar plains. In all the districts of plateau region Dhanbad district has high concentration of agricultural infrastructure with a rank of 18th in the state.

The situation changed drastically in 1990-91.There was too many up and down in the concentration of agricultural infrastructure among the districts in Bihar. Patna district continued to retain rank 1st in the state. It was followed by Saran (2nd), Begusarai (3rd), Nalanda (4th), Champaran (East) (5th), Dhanbad (8th) etc. Santhal Pargana district recorded last position in the state i.e. 31st followed by Singhbhum (30th), Ranchi (29th) districts etc.

There were some districts that have shown high growth of agricultural infrastructure during 1980-81 to 1990-91 periods. It proves that some district have performed well than others. Champaran (East) and Dhanbad has shown high growth of infrastructure during 1980-81 to 1990-91. Champaran (East) changed its rank from 19th position to 5th position while Dhanbad district shifted from 18th to 6th position during 1980-81-1990-91.

The following table shows the change of position of districts from 1981 to1991.

Figure 3.1

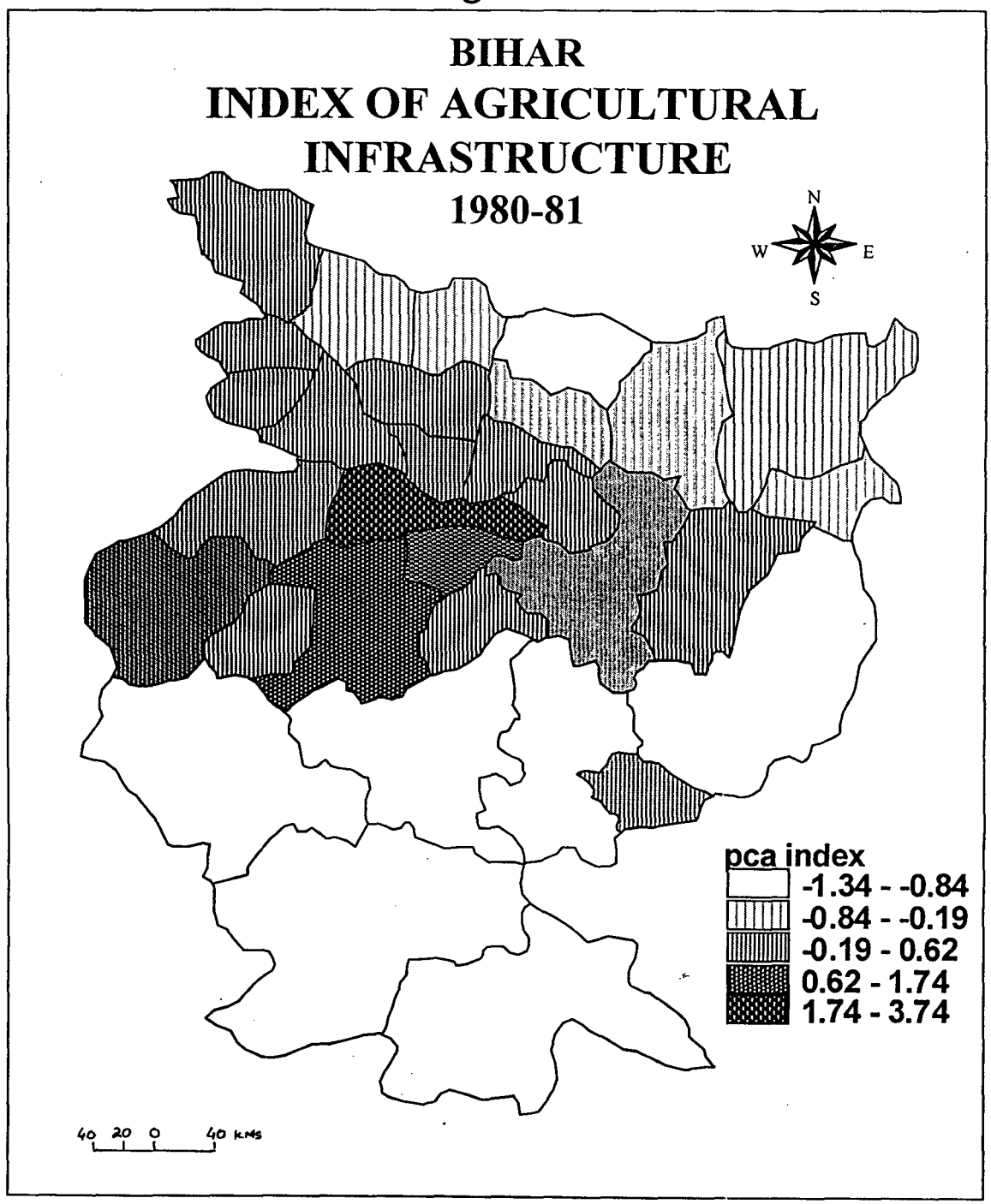
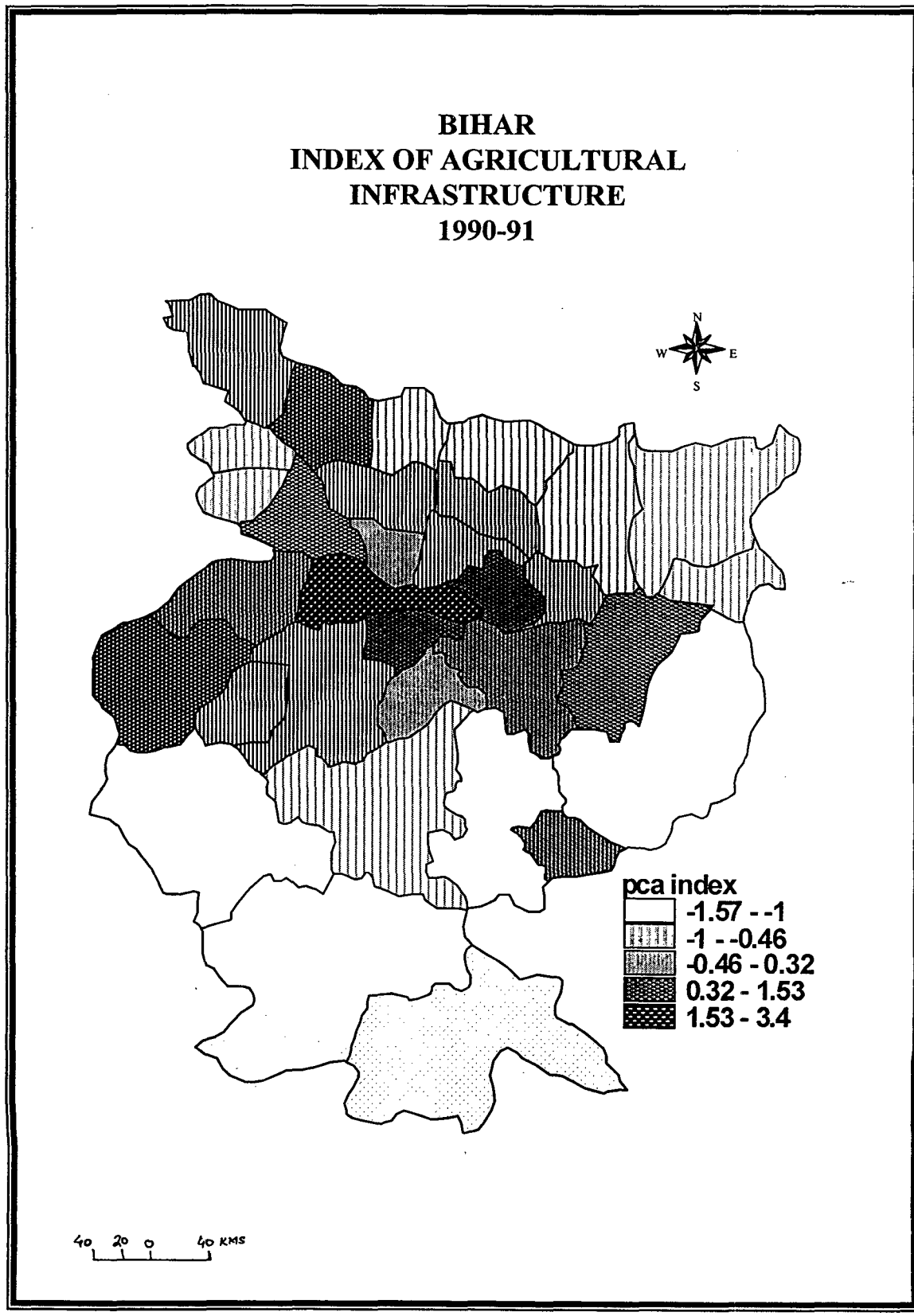

BIHAR
INDEX OF AGRICULTURAL INFRASTRUCTURE
1980-81
N
W
E
S
pca index
-1.34 - -0.84
-0.84 - -0.19
-0.19 - 0.62
0.62 - 1.74
1.74 - 3.74
40 20 0 40 kms

Figure 3.2


BIHAR
INDEX OF AGRICULTURAL
INFRASTRUCTURE
1990-91
N
W
E
S
pca index
-1.57 - -1
-1 - -0.46
-0.46 - 0.32
0.32 - 1.53
1.53 - 3.4
40 20 0 40 KMS

CHAPTER - IV

LEVELS OF AGRICULTURAL DEVELOPMENT IN BIHAR

Agricultural development is closely related to the productivity of land in terms of values of output. According to Bhatia, 'agricultural productivity is a function of a variety of factors including physical, social, economic and technological. Each acquiring their, specificities as component in an interacting system over time. The combined effect of these factors manifests itself in per hectare productivity in any area".[1]

In case of Bihar in this research three indicators have been selected to measure the level of agricultural development. These are :--

i. Agricultural productivity in terms of Rupees per agricultural workers (B1)

ii. Agricultural productivity in terms of Rupees per hectare gross sown area (B2)

iii. Cropping intensity (B2)

The above mentioned indicators of agricultural development have been discussed briefly for Bihar as well as its districts .

4.1 Agricultural Productivity (Rs./agricultural workers) (B1)

It has been considered as important indicators of the agricultural development by many scholars.

For the State of Bihar as a whole agricultural productivity in terms of Rs. Per agricultural workers was estimated to be Rs.745.54. There are large scale variations in terms of productivity among the districts in the state. Rohtas district shows highest productivity with Rs.1861.70 per agricultural workers in the state. It is followed by Bhojpur (Rs.1546.69), Aurangabad (Rs.1331.71.) Siwan (Rs.1228.28), Gopalganj (Rs.1192.60) districts etc. Giridih districts have lowest productivity with Rs.241.43.

[1] S.S. Bhatia, " A New Approach to Measure Agricultural Productivity in Uttar Pradesh", Economic Geography, vol. 93, 1968 pp. 244-60.

Followed by Palamu (Rs.298.38) Hazaribagh (Rs.318.91), Dhanbad (Rs.325.52), Santhal Pargana (Rs.477.54) districts etc.

Other district like Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Saharsa, Purnea, Gaya, Nawada, Santhal Pargana and Ranchi districts has productivity ranges between Rs.325.52-614.77 per agricultural workers while Champaran (west), Champaran (East), Samastipur, Katihar, Patna, Munghyr and Bhagalpur has productivity Rs.614.77-894.21. Per agricultural workers, Gopalganj, Siwan, Saran, Begusarai, Aurangabad, Nalanda and Singhbhum have high productivity with Rs.894.21-1331.71 per agricultural workers.

Table 4.2 : Agricultural Productivity (Rs. /agricultural worker) in Bihar

	B1*	1980-81	B1*	1990-91
Very low	325.52>	Hazaribagh, Giridih, Dhanbad, Palamu	>1456.38	Darbhanga, Purnea, Munghyr, Bhagalpur, Giridih, Santhal Pargana, Palamu, Ranchi
Low	325.52-614.77	Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Saharsa, Purnea, Gaya, Nawada, Santhal Pargana, Ranchi	1456.38-2240.35	Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Saharsa, Gaya, Dhanbad
Medium	614.77-894.21	Champaran(west), Champaran(East), Samastipur, Katihar, Patna, Munghyr, Bhagalpur	2240.35-3112	Champaran(west), Champaran(East), Samastipur, Patna, Hazaribagh
High	894.21-1331.71	Gopalganj, Siwan, Saran, Begusarai, Aurangabad, Nalanda, Singhbhum	3112-4700.54	Siwan, Saran, Bhojpur, Nalanda, Nawada, Katihar, Singhbhum
Very High	>1331.71	Bhojpur, Rohtas	>4700.54	Gopalganj, Rohtas, Aurangabad, Begusarai

**Agricultural Productivity (Rs. / agricultural workers)*

Source : Centre for Monitoring Indian Economy, India's Agricultural Sector July 1996 and Census of India, 1981 & 1991.

During 1990-91, agricultural productivity in terms of Rs. per agricultural workers at the state level increased upto Rs. 1373.76. It recorded a growth rate of 84.26 percent during 1980-81-1990-91. Begusarai showed highest productivity with Rs.5904.57 per agricultural workers. It has claimed approximately 470.06 percent growth in agricultural productivity during 1980-81-1990-91. After Begusarai district, Gopalganj has recorded high productivity with Rs.5482. These districts were followed by Aurangabad (Rs.5417.54), Rohtas (Rs.5139.77), Katihar (Rs.4700.54) districts etc. Giridih recorded low productivity in the state with Rs.702.45. However it accounted over of 190.95 percent growth rate during 1980-81-1990-91. After Giridih, Santhal Pargana had next low productivity of Rs.858.69. per agricultural workers followed by Ranchi (Rs.905.65), Darbhanga (Rs.949.27), Purnea (Rs.1126.50), Bhagalpur (Rs.1354.92) etc.

It is interesting to notice that though almost all the district have recorded increase in their productivity during 1980-81 and 1990-91. However, these may not be real. It may be largely due to inflation. But, after looking at the map it is clear that the regional pattern in terms of growth rate near to be by and large unchanged. District from Central Western Bihar continue to retain their top position and as one moves away from these the productivity tends to decrease the only exception is district Singhbhum where has scored high value that is more than Rs. 4700 per agricultural worker.

4.2. Agricultural Productivity in terms of Rs per hectare of gross sown area (GSA) (B2)

During 1980-81, agricultural productivity in terms of Rs. per hectare of gross sown area of the state was around Rs.2243.38. As shown in the table (4.4), there were variations among districts Sitamarhi district has highest agricultural productivity in terms of Rs. per hectare with Rs.2813.26 It has been followed by Siwan (Rs.2782.42), Champaran (East) (Rs.2768.68), Nalanda (Rs.2736.88) Saran (Rs.2682.11), Gopalganj (Rs.2649.87) districts etc. At the extreme are district like Palamu with very low productivity i.e. Rs.1341.27. It is followed by Ranchi (Rs.1562.97), Madhubani (Rs.1700.30), Hazaribagh (Rs.1801.705), Dhanbad (Rs.1811.19), Singhbhum (Rs.1811.36) districts etc.

Other districts like Saharsa, Purina, Gaya, Nawada and Giridih has productivity between Rs.1811.36-2054.23. per hectare of GSA while Rohtas, Aurangabad, Vaishali, Patna, Begusarai, Munghyr, Katihar and Santhal Pargana has productivity between Rs.2054.23-2262.17. Champaran (west), Muzaffarpur, Darbhanga, Samastipur, Bhojpur and Bhagalpur have high productivity ranges between Rs.2262.17-2572.27.

Map showing the spatial as well as temporal variation reveal that there emerge a sharp north – south division among the districts as far as per hectare product is concerned. Central north – western district mostly falling in the Ganga River plain have higher productivity and as one move to south the productivity decreases sharply. However, it is encouraging that the productivity have increased over the year. It was around Rs. 2813 per hectare for the most developed district in1980 – 81 and it increased upto Rs.7782 in 1990 – 91.

It seems the role of geographical factors continues to be over delimiting in determining the productivity in the State. The districts from the plateau and hill regions have shown low productivity as compare to the district from the plain. However, the regional patterns have remained by and large unchanged. Similarly most of the districts in the north plain have improved their position and district in the plateau region have lost their position. This shows that environmental factors continue to dominate in the pattern and the nature of agriculture development in the State. Moreover, the districts endowed with the modern infrastructure have also done well.

District Patna recorded highest agricultural productivity with Rs. 7785.01 per hectare of GSA. It has shown 257.36 percent growth in the productivity during 1980-81-1990-91. It was followed by Bhojpur, Champaran(East), Nalanda, Muzaffarpur, and Rohtas districts productivity ranging between Rs. 7300.58 to Rs. 6626.23 respectively. Palamu district has been shown low productivity in terms of Rs. per hectare GSA in the state with Rs. 3586.63. Dhanbad (Rs. 3788.12) Hazaribagh (Rs. 3898.30), Giridih (Rs. 4316.81), Ranchi Rs. (4550.39) Singhbhum (Rs. 4693.3) and Bhagalpur (Rs. 4720.30), were among the low productivity districts in the States

Table : Indicators of Agricultural Development in Bihar

DISTRICTS	1980-81 RsAg_W_ B 1	1980-81 Rsha B 2	1980-81 Crp_Int_ B 3	1990-91 RsAg_W_ B 1	1990-91 Rsha B 2	1990-91 Crp_Int_ B 3
1.Champaran(West)	894.21	2475.64	149.13	3112.00	6256.99	140.74
2.Champaran(East)	834.56	2768.68	124.10	3082.04	7232.42	128.97
3.Gopalganj	1192.60	2649.87	143.64	5482.48	5876.19	184.11
4.Siwan	1228.28	2782.42	149.46	3854.55	6244.51	159.40
5.Saran	1089.23	2682.11	146.72	3845.36	6656.56	149.72
6.Sitamarhi	497.16	2813.26	148.15	1635.87	5695.84	147.01
7.Muzaffarpur	614.77	2358.59	141.83	2035.15	6657.48	155.95
8.Vaishali	552.70	2161.16	146.55	2240.35	5598.64	158.95
9.Madhubani	550.95	1700.30	136.34	1970.51	5730.57	134.32
10.Darbhanga	493.03	2543.19	149.77	949.27	5738.74	173.98
11.Samastipur	729.89	2354.76	140.02	2924.04	6175.49	145.23
12.Begusarai	1035.78	2113.72	146.67	5904.57	5606.35	170.77
13.Saharsa	519.25	2025.86	136.46	1665.17	5602.56	156.41
14.Purnea	549.24	2054.23	146.90	1126.50	5199.07	149.49
15.Katihar	653.98	2094.85	155.99	4700.54	5429.64	163.92
16.Bhojpur	1546.69	2572.27	136.55	4253.54	7300.58	145.21
17.Rohtas	1861.70	2099.61	152.08	5139.77	6626.23	151.27
18.Aurangabad	1331.71	2168.95	148.14	5417.54	5738.78	138.34
19.Patna	741.64	2178.45	143.24	2989.64	7785.01	138.12
20.Gaya	593.41	1986.47	112.58	1719.85	5484.82	126.74
21.Nalanda	1076.69	2736.88	131.34	4556.55	6685.97	146.53
22.Nawada	553.19	1994.92	157.62	3589.80	5655.70	137.33
23.Munghyr	657.57	2244.05	134.53	1456.38	6007.63	126.63
24.Bhagalpur	757.08	2372.08	135.09	1354.92	4720.30	122.79
25.Hazaribagh	318.91	1801.75	115.26	2486.07	3898.30	114.51
26.Giridih	241.43	1862.28	115.61	702.45	4316.81	108.58
27.Santhal Pargana	477.54	2262.17	115.54	858.69	5555.65	108.01
28.Dhanbad	325.52	1811.19	102.56	2023.07	3788.12	105.23
29.Palamu	298.38	1341.27	141.30	1416.49	3586.63	111.95
30.Ranchi	560.51	1562.97	113.29	905.65	4550.39	111.13
31.Singhbhum	1145.61	1811.36	101.13	3879.86	4693.38	105.20
BIHAR	745.54	2243.38	134.08	1373.76	5812.762	136.13
Mean	771.72	2205.98	136.05			
S.D	385.04	379.30	15.75	2815.44	5680.50	139.24
C.V	49.89	17.19	11.58	1550.00	1014.35	21.48
				55.05	17.86	15.42

Table 4.4: Agricultural Productivity (Rs. /hectare) in Bihar

	B2*	1980-81	B2*	1990-91
Very low	1811.36>	Madhubani, Palamu, Hazaribagh, Dhanbad, Ranchi, Singhbhum	4720.3>	Bhagalpur, Palamu, Hazaribagh, Giridih, Dhanbad, Ranchi, Singhbhum
Low	1811.36-2054.23	Saharsa, Purnea, Gaya, Nawada, Giridih	4720.3-5484.82	Purnea, Katihar, Gaya
Medium	2054.23-2262.17	Rohtas, Aurangabad, Vaishali, Patna, Begusarai, Munghyr, Katihar, Santhal Pargana	5484.82-5876.19	Gopalganj, Sitamarhi, Madhubani, Darbhanga, Saharsa, Vaishali, Begusarai, Aurangabad, Nawada, Santhal Pargana,
High	2262.17-2572.27	Champaran (west), Muzaffarpur, Darbhanga, Samastipur, Bhojpur, Bhagalpur	5876.19-6256.99	Champaran(west), Siwan, Darbhanga, Munger
Very high	>2572.27	Champaran(East), Sitamarhi, Gopalganj, Siwan, Saran, Nalanda	>6256.99	Champaran(East), Saran, Muzaffarpur, Bhojpur, Rohtas, Patna, Nalanda

** Agricultural Productivity Rs. per hectare gross sown area.*

Source: Centre for Monitoring Indian Economy

During 1990-91, agricultural productivity in terms of Rs. Per hectare in Bihar has become Rs. 5812.76. It has been shown 159.10 percent growth during 1980-81-1990-91. There has been variation found among the districts in the state in agriculture productivity.

District Patna recorded highest agricultural productivity with Rs. 7785.01 per hectare of GSA. It has shown 257.36 percent growth in the productivity during 1980-81-1990-91. It was followed by Bhojpur, Champaran(East), Nalanda, Muzaffarpur, and Rohtas districts productivity ranging between Rs. 7300.58 to Rs. 6626.23

respectively. Palamu district has been shown low productivity in terms of Rs. per hectare GSA in the state with Rs. 3586.63. Dhanbad (Rs. 3788.12) Hazaribagh (Rs. 3898.30), Giridih (Rs. 4316.81), Ranchi Rs. (4550.39) Singhbhum (Rs. 4693.3) and Bhagalpur (Rs. 4720.30), were among the low productivity districts in the States

4.2 The Cropping intensity (B3)

Cropping intensity is one of the most important indicators of agricultural development.

During 1980-81, cropping intensity of the state was 134.08 percent while various disparities have been found at the districts level in the state. As shown in the table (4.3), district Katihar has highest cropping intensity with 155.99 percent followed by Nawada (157.62 percent), Rohtas (512.08 percent) etc. while district Singhbhum has been shown very low cropping intensity with 101.13 percent. It was followed by Dhanbad (102.56 percent), Gaya (112.58 percent), Ranchi (113.29 percent), Hazaribagh (115.26 percent), Santhal Pargana (115.54 percent), Giridih (115.61 percent) districts etc.

Some other districts, like Champaran (East) and Nalanda has cropping intensity of 124.10 and 131.34 percent respectively. Muzaffarpur, Madhubani, Saharsa, Samastipur, Bhojpur, Munger, Bhagalpur and Palamu have cropping intensity between 131.34 -141.83 percent.

Table 4.3: Cropping intensity in Bihar

	B3*	1980-81	B3*	1990-91
Very low	115.61>	Gaya, Hazaribagh, Giridih, Dhanbad, Santhal Pargana, Ranchi, Singhbhum	114.51>	Palamu, Hazaribagh, Giridih, Dhanbad, Santhal Pargana, Ranchi, Singhbhum
Low	115.61-131.34	Champaran (East), Nalanda	114.51-134.32	Champaran (East), Madhubani, Gaya, Munghyr, Bhagalpur
Medium	131.34-141.83	Muzaffarpur, Madhubani, Saharsa, Samastipur, Munger, Bhagalpur, Palamu	134.32-147.01	Champaran (west), Sitamarhi, Bhojpur, Patna, Samastipur, Nalanda, Aurangabad, Nawada
High	141.83-149.77	Champaran (west), Gopalganj, Siwan, Saran, Vaishali, Sitamarhi, Darbhanga, Purnea, Patna, Begusarai, Aurangabad	147.01-163.92	Siwan, Saran, Muzaffarpur, Vaishali, Saharsa, Purnea, Katihar, Rohtas
Very High	>149.77	Rohtas, Nawada, Katihar	>163.92	Gopalganj, Darbhanga, Begusarai

** Cropping intensity*

Source: Indian Agricultural Statistics 1980 – 81 and 1990 – 91.

For the state as a whole cropping intensity increased by 1.53 percent from 1980 – 81 to 1990 - 91.the district was breakup showing the table shows that Gopalganj has highest cropping intensity in the state with 105.20 percent. It has been followed by Dhanbad (105.23 percent), Santhal Pargana (108.01 percent), Giridih (108.58 percent), Ranchi (110.13 percent), Palamu (111.99 percent, Hazaribagh (114.51 percent) districts etc. and districts like Champaran (East), Madhubani, Gaya, Munghyr and Bhagalpur has cropping intensity was very low i.e. it ranged between 114.51-134.32 percent.

Once again looking at the maps showing cropping intensity it is clear that natural factors like fertile soil, possibilities of developing artificial irrigation through canals and other mean of lift irrigation at low cost each have influenced the level of agricultural intensity in the State. As opposed to there stringent environmental condition, rugged terrain and high cost in the development of artificial irrigation are largely responsible for low agricultural intensity in the southern district of the State. Moreover, it is also important to know that though there is an overall increase in the agricultural intensity yet the north – south division continued from 1981 -1991.

After discussion the level of agricultural development for all three indicators it is essential to assess the relative position of these districts on the basis of combined results. For this purpose composite index of agricultural development has been worked out. Principal Component Analysis was used to find the aggregate score of each district and there after these district have been divided into five groups i.e. very high, high, medium, low and very low levels of development.

4.4 Composite Index of Agricultural Development

During 1980-81, district Siwan secure high score and got 1st position in the agricultural development in the state. It was followed by Rohtas, Bhojpur, Saran, Gopalganj, Aurangabad, Nalanda, Champaran (west), Sitamarhi, Begusarai districts etc. which secure 2nd to 10th position respectively. Dhanbad securing very low score and gets last i.e.31st position in the state as agricultural development. The other districts in their group are Ranchi, Giridih, Hazaribagh, Palamu and Gaya with the position ranging between 30th to 26th respectively.

The situation has changed for individual districts in 1991, though the regional pattern remains by and large same. Gopalganj secure 1st position while Patna, Darbhanga, Muzaffarpur, Bhojpur, Siwan, Saran, Rohtas, Begusarai and Nalanda secured rank 2nd to 10th position respectively. Singhbhum secure very low score among the other districts and has last position in the state in terms of agricultural development. There are some districts that have high growth of agricultural development and improved their position as shown in the table. It was noticed that some district have gained higher position while other have loss in 1990 – 91.It is worth noticing that all these districts have improved their position owing to higher

Table : Index of Agricultural Development in Bihar

DISTRICTS	1980-81		1990-91	
	PCA	Rank	PCA	
1.Champaran(West)	0.81	8	0.37	16
2.Champaran(East)	0.45	12	0.58	11
3.Gopalganj	1.22	5	1.20	1
4.Siwan	1.57	1	0.81	6
5.Saran	1.22	4	0.78	7
6.Sitamarhi	0.75	9	0.29	17
7.Muzaffarpur	0.16	16	1.01	4
8.Vaishali	-0.03	19	0.52	12
9.Madhubani	-0.86	24	-0.03	19
10.Darbhanga	0.46	11	1.02	3
11.Samastipur	0.24	14	0.45	15
12.Begusarai	0.46	10	0.70	9
13.Saharsa	-0.49	22	0.48	13
14.Purnea	-0.15	21	0.11	18
15.Katihar	0.25	13	0.47	14
16.Bhojpur	1.34	3	0.99	5
17.Rohtas	1.52	2	0.76	8
18.Aurangabad	0.90	6	-0.04	20
19.Patna	0.12	17	1.11	2
20.Gaya	-1.09	26	-0.35	23
21.Nalanda	0.87	7	0.69	10
22.Nawada	0.06	18	-0.05	21
23.Munghyr	-0.12	20	-0.07	22
24.Bhagalpur	0.16	15	-0.83	25
25.Hazaribagh	-1.55	28	-1.52	28
26.Giridih	-1.56	29	-1.39	27
27.Santhal Pargana	-0.80	23	-0.76	24
28.Dhanbad	-1.86	31	-1.80	30
29.Palamu	-1.45	27	-1.71	29
30.Ranchi	-1.62	30	-1.21	26
31.Singhbhum	-0.98	25	-2.60	31

rate of agricultural growth in 1990 – 91 over 1980 – 81. Patna districts has shown high agricultural development during 1980-81 – 1990-91 because it improved its position from 17th in 1980 – 81 to 2nd in 1990 – 91 similarly Muzaffarpur districts has also improved its position.

The above discussion shows that the districts in the north Bihar plains have highly developed agriculture activity while districts in the plateau regions are backward in agricultural development.

Figure 4.1

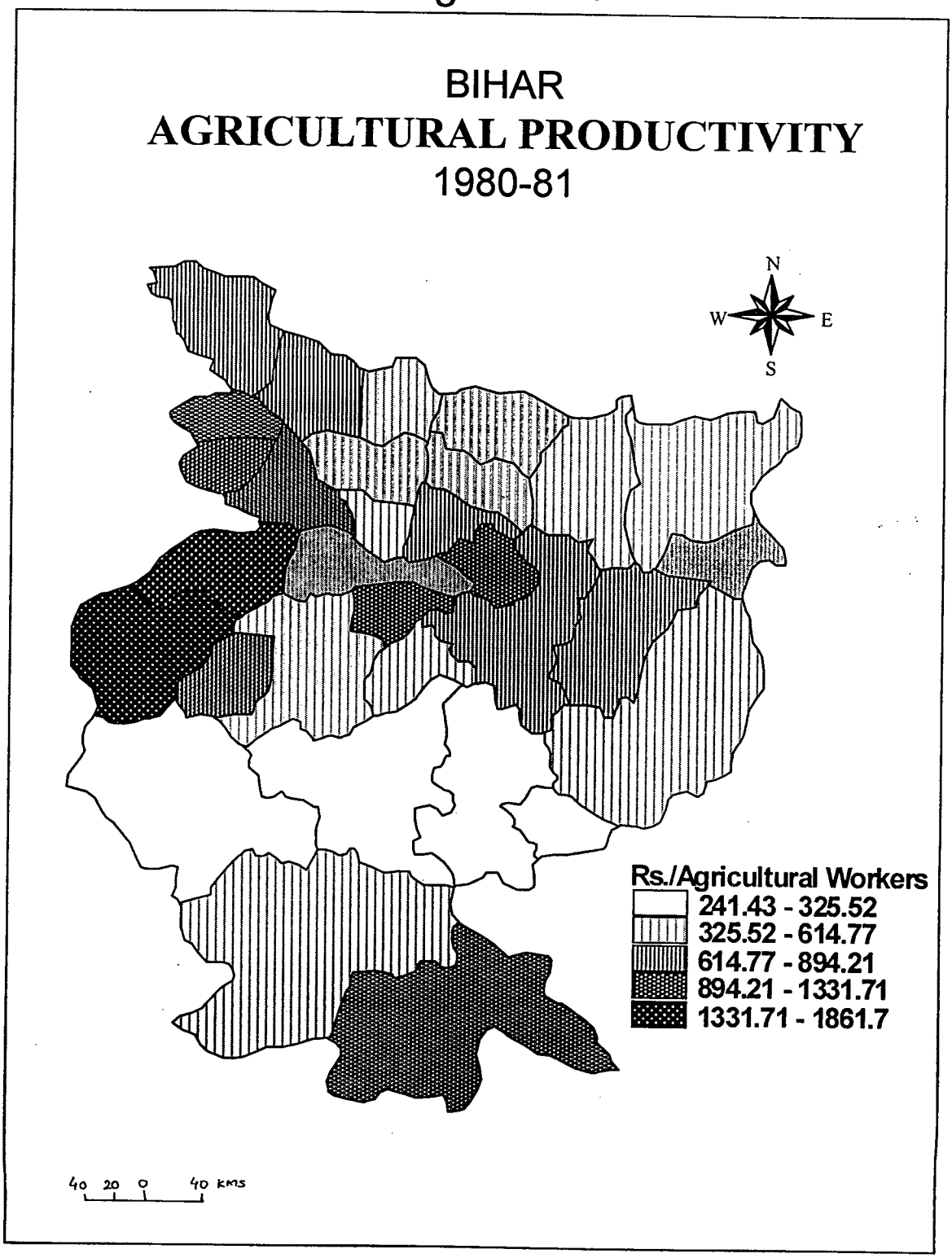

BIHAR
AGRICULTURAL PRODUCTIVITY
1980-81
N
W
E
S
Rs./Agricultural Workers
241.43 - 325.52
325.52 - 614.77
614.77 - 894.21
894.21 - 1331.71
1331.71 - 1861.7
40 20 0 40 KMS

Figure 4.2

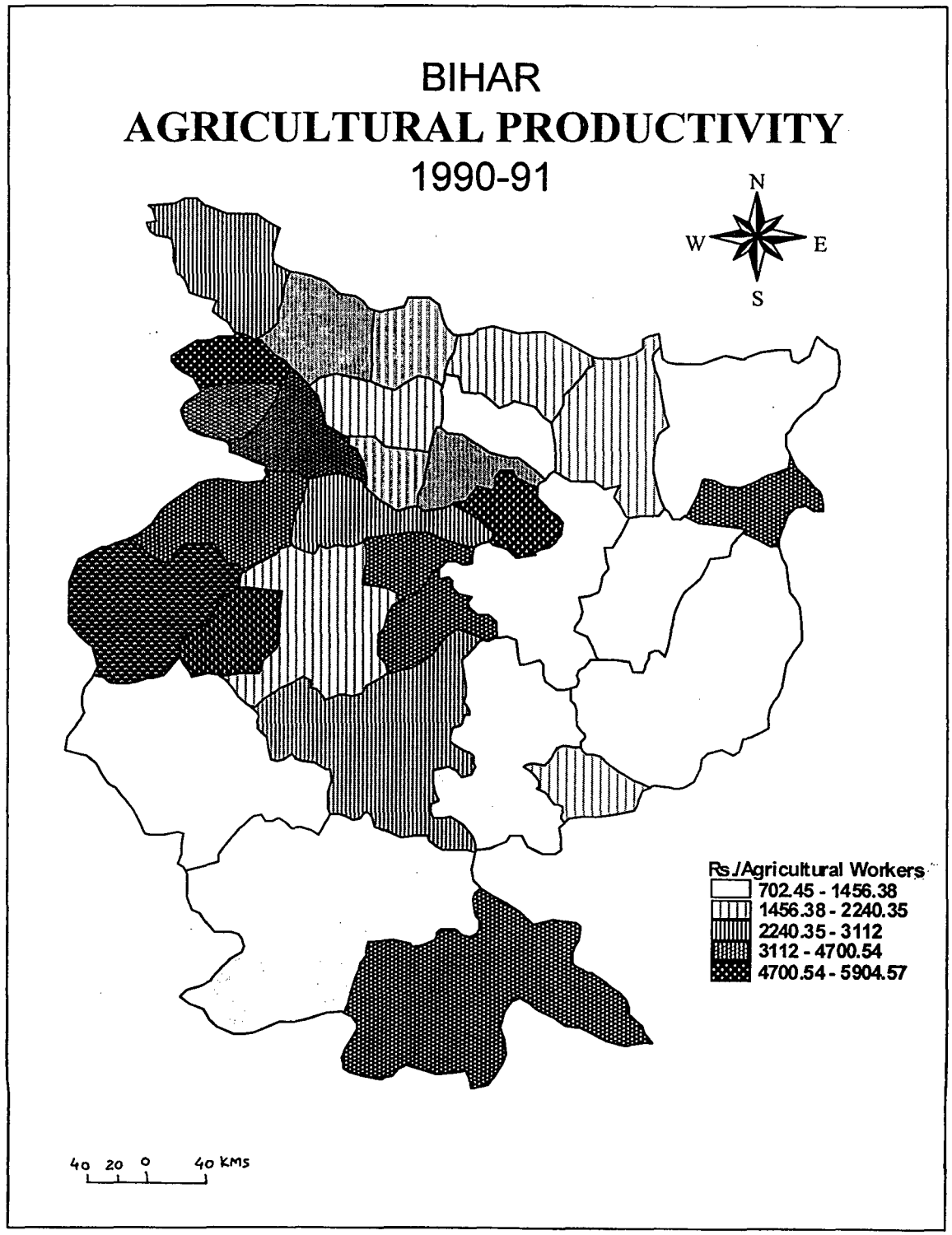

BIHAR
AGRICULTURAL PRODUCTIVITY
1990-91
N
W
E
S
Rs./Agricultural Workers
702.45 - 1456.38
1456.38 - 2240.35
2240.35 - 3112
3112 - 4700.54
4700.54 - 5904.57
40 20 0 40 KMS

Figure 4.3

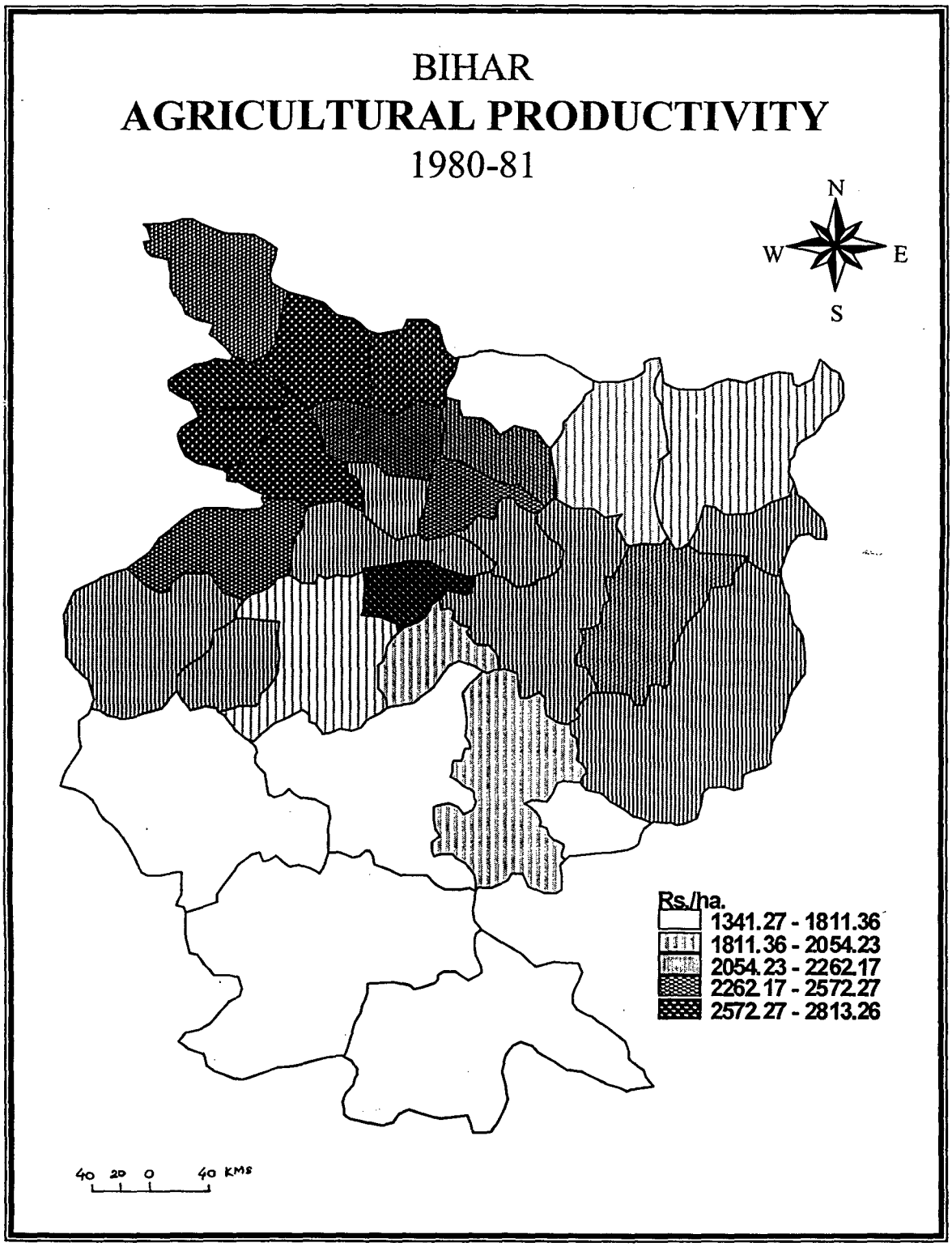

BIHAR
AGRICULTURAL PRODUCTIVITY
1980-81
N
W
E
S
Rs./ha.
1341.27 - 1811.36
1811.36 - 2054.23
2054.23 - 2262.17
2262.17 - 2572.27
2572.27 - 2813.26
40 20 0 40 KMS

Figure 4.4

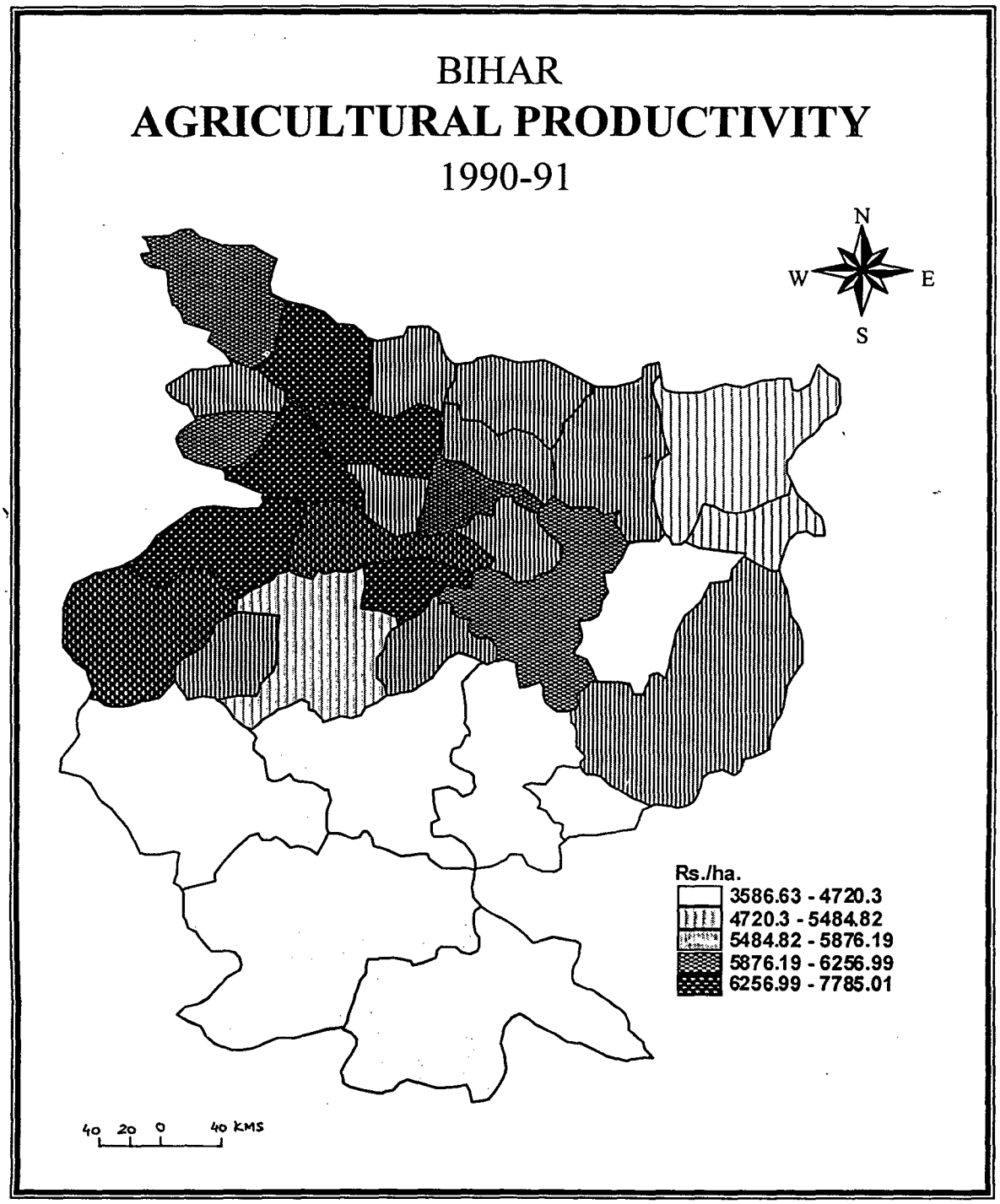

BIHAR
AGRICULTURAL PRODUCTIVITY
1990-91
N
W
E
S
Rs./ha.
3586.63 - 4720.3
4720.3 - 5484.82
5484.82 - 5876.19
5876.19 - 6256.99
6256.99 - 7785.01
40 20 0 40 KMS

Figure 4.5

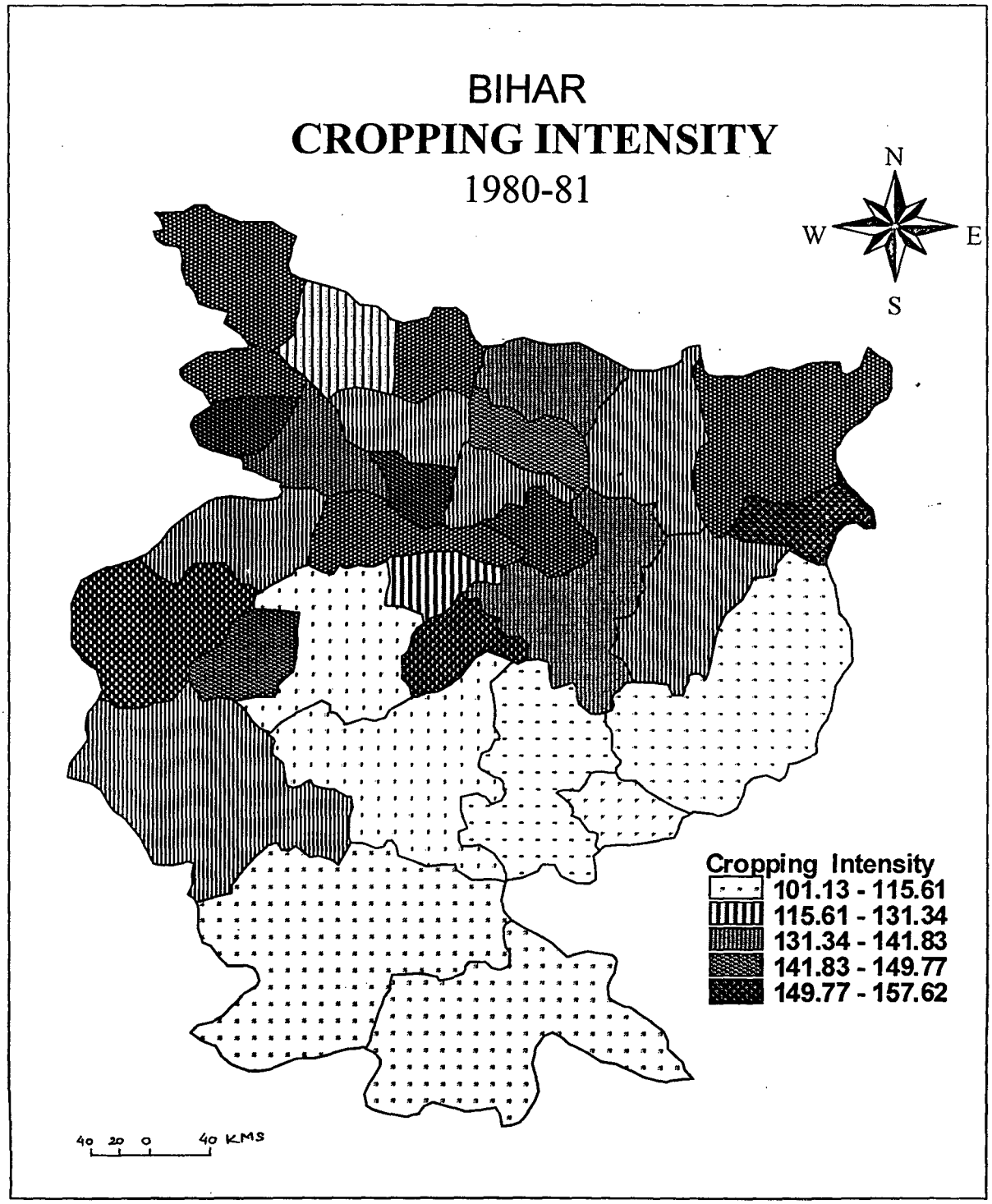

BIHAR
CROPPING INTENSITY
1980-81
N
W
E
S
Cropping Intensity
101.13 - 115.61
115.61 - 131.34
131.34 - 141.83
141.83 - 149.77
149.77 - 157.62
40 20 0 40 KMS

Figure 4.6

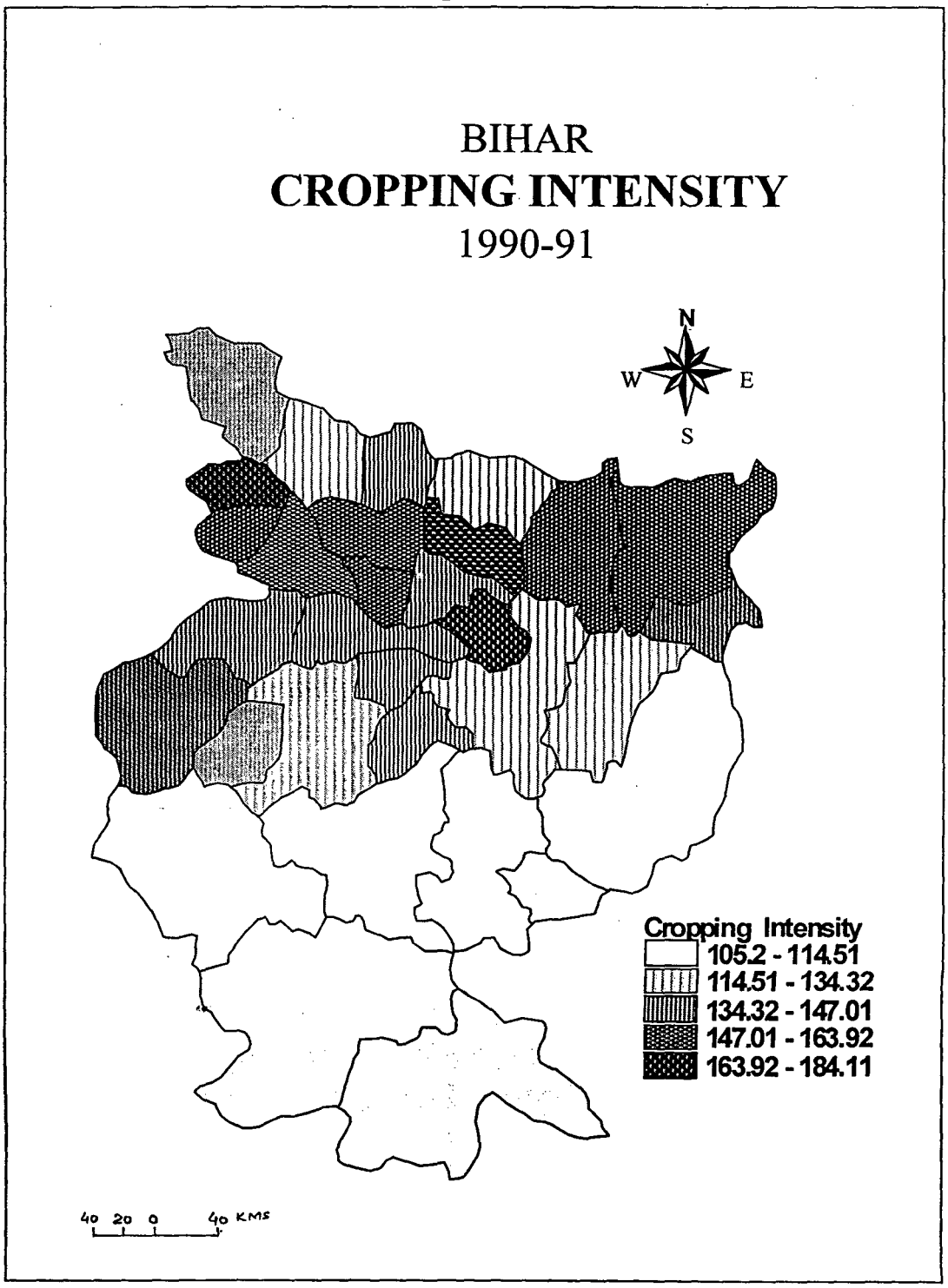

BIHAR
CROPPING INTENSITY
1990-91
N
W
E
S
Cropping Intensity
105.2 - 114.51
114.51 - 134.32
134.32 - 147.01
147.01 - 163.92
163.92 - 184.11
40 20 0 40 KMS

Figure 4.7

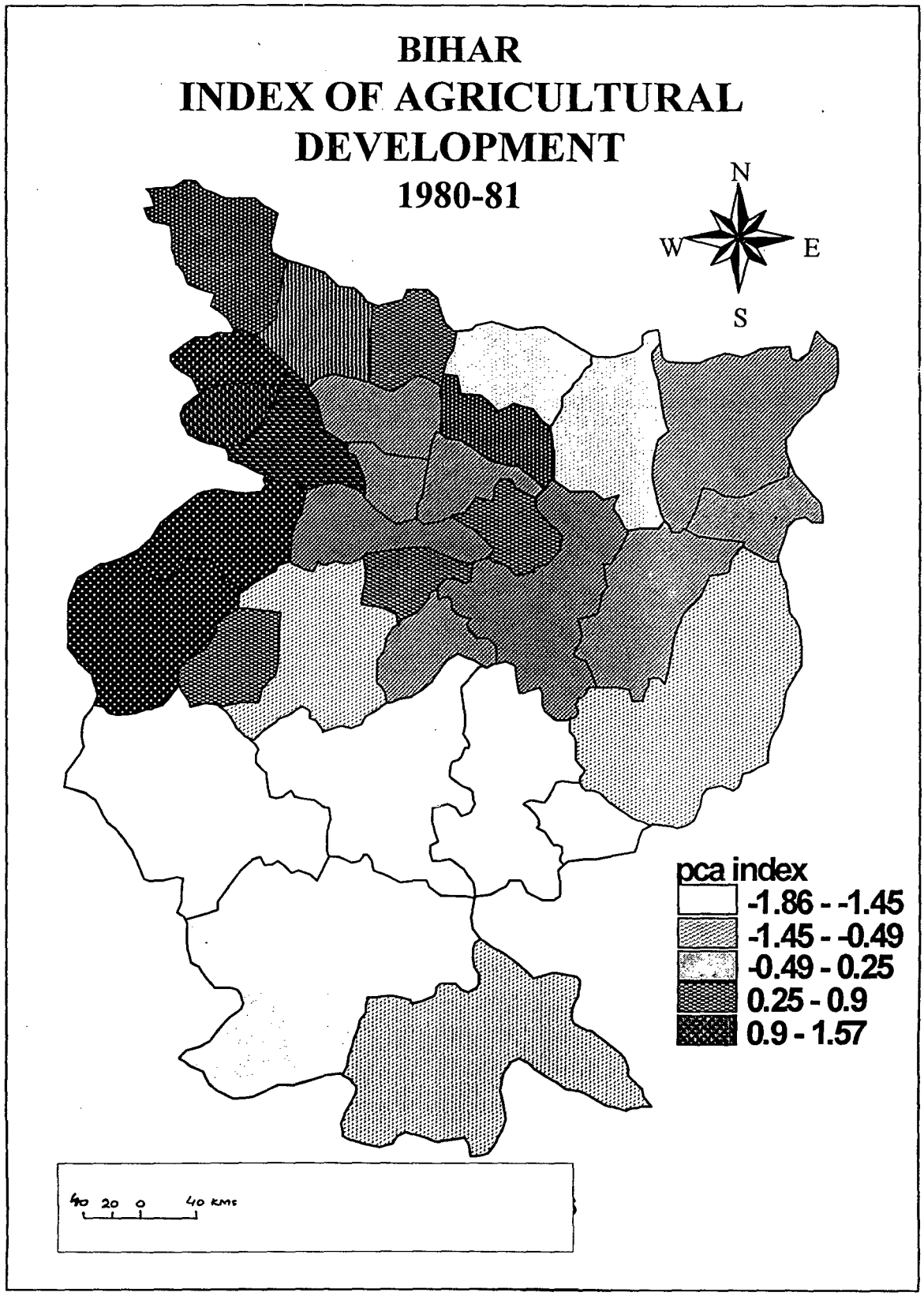
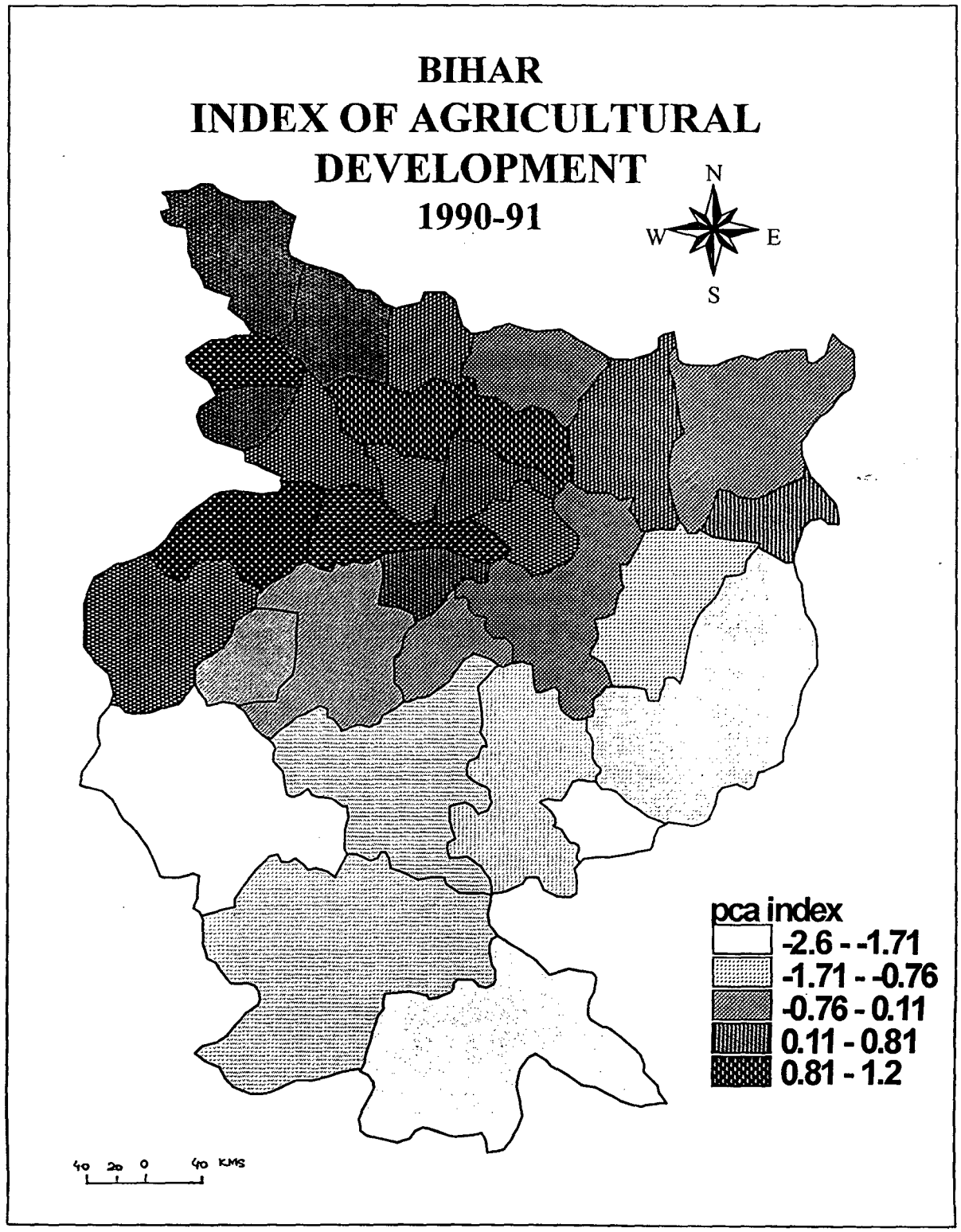

BIHAR
INDEX OF AGRICULTURAL DEVELOPMENT
1980-81
N
W
E
S
pca index
-1.86 - -1.45
-1.45 - -0.49
-0.49 - 0.25
0.25 - 0.9
0.9 - 1.57
40 20 0 40 KMS

Figure 4.8


BIHAR
INDEX OF AGRICULTURAL DEVELOPMENT
1990-91
N
W
E
S
pca index
-2.6 - -1.71
-1.71 - -0.76
-0.76 - 0.11
0.11 - 0.81
0.81 - 1.2
40 20 0 40 KMS

CHAPTER -V

IFRASTRUCTURE AND AGRICULTURAL DEVELOPMENT IN BIHAR

Infrastructure and agricultural development are complementary to each other. Where adverse environment and economic factors constraint on agricultural development there infrastructure comes forward to overcome these constraints. According to Dandekar[1] and Donde[2], 'In order to over come environmental constraints and minimizing disparities in an increasing the level of agricultural productivity, a package of technological measures like irrigation, fertilizers, HYV seeds and mechanization has been adopted'. These infrastructure play a major role in agricultural development in various ways. For example, water is an important pre – requisite for crops production and it may be secure by the developing irrigational infrastructure. Irrigation on the one hand make up the moisture deficiency in soil and ensure proper sustained growth of crops and it also helps in stabilizing agricultural production on the other. It also helps in agricultural development, by providing necessary condition for the use of other modern inputs like HYV seeds .This help in getting high output from the limited land .Similarly electricity is helpful in the smooth functioning of pump sets for getting more water for irrigation for time to time. Credit from banks, secured availability of money for high investment in agricultural sector have gained enhanced significance in green revolution period for agricultural development. Besides these other infrastructures like market centers, transport, communication, education, health facilities, and agricultural training institutions etc. who have gained prominence. It goes beyond doubt that adequate number of market centers, transport and communications leads to easy access and minimizes the cost of acquiring the agricultural inputs.

Consequently it helps in faster agricultural development. Apart from these the availability of optimum cold storage facilities to promote the agricultural development as the chances of post harvest crop losses are minimized. Moreover, a storage facility

[1] V.M. Dandekar, "Regional Variation s in Agricultural Development and Productivity", (Rapporteur's Report), Indian Journal of Agricultural Economics , Vol XIX, 1964, pp 253-60
[2] W.B. Donde. "Tractors in Indian Agriculture", Agricultural situation in India, Vol XXIV, 1969 pp 291-95

can also control too much oscillation in the price of agricultural commodity because it can control the speculative demand and supply of the same. Education too is helpful in the agricultural development. Educated farmers are able to know about the new technology and can decide optimum use of available infrastructure for agricultural development. Similarly, health facilities provide good health to the agricultural workers and a healthy worker is generally more efficient. It goes without saying that highest efficiency will lead to highest growth. Thus it can be said that infrastructural and agricultural development and inseparable from each other. But one or few of these infrastructures are unlikely to yield desired result. These are mostly used in a packet and once used as a package input they have cumulative results. As opposed to this one or a few will result into diseconomies and increases the cost without making significant contribution in the output. In the back drop of these discussion a Attempts have been made in this chapter to examine the relationship between availability of infrastructure and agricultural development in Bihar. Therefore it can be say that infrastructural and agricultural development can not be occur and it became primitive in nature additionally it any also be say that all infrastructure are complementary to each other. With out each other, they can not be able provide sufficient result for the agricultural development. If any region which are well developed in irrigation facilities but not use appropriate fertilizers or HYVS are not able to get more output from land in the same way if number of distribution transformers are abundant in the agricultural region and it gel lot provide electricity appropriate availability of pumpsets energized can not be work for irrigation purposes. Therefore, agricultural development is the results of balance between infrastructure to infrastructure and infrastructure to agricultural inputs. Without this, agricultural development can not be occur.

On the basis of above discussion it can be said that attempts have been made to examine the relationship between to examine the relationship between availability of infrastructure and agricultural development in Bihar .In order to study the availability of infrastructural facilities, nine Indicators have taken and for showing agricultural development we have taken three indicators were selected that are discussed in the previous chapter.

In this chapter two main points have been discussed:-

i) effects of concentration of agricultural infrastructure on agriculture development on the basis of PCA (Principal Component Analysis) which has been worked out for the overall infrastructure and the indicators of agricultural development in the previous chapters.

ii)To study the correlation among the indicators of infrastructure and between the indicators of infrastructure and that of agricultural development.

5.1 Infrastructure and agricultural development.

Through the brief discussion on the composite Index of infrastructure and agricultural development in previous chapter only the distribution and concentration of infrastructure and developed agriculture was shown in all the districts of Bihar. Thus it couldn't show the effects of infrastructure on agricultural development and vice-versa.. It was broadly assumed that the district which has high concentration of agricultural infrastructure has also shown development of agriculture. For example Patna, Saran. Begusarai, Bhojpur, Rohtas and Nalanda districts have high concentration of agricultural infrastructure and these were also developed agriculturally. But in the case of Dhanbad and Bhagalpur, where concentration of infrastructure is high, but levels of agricultural development are not high. The main reason besides abundant availability of agricultural infrastructure these districts are not favourable for cultivation from the point of view of environmental constraints. It means there may be climate , physiographical or social constraints. Dhanbad districts has predominantly mining as a major activity .Thus ,agriculture gets only second preference. Moreover, the environmental hazards created by mining ,ash dumping ,subsidence of and deforestation etc. have made agriculture difficult in this district.

There are some districts in the state where concentration of agricultural infrastructure as well as agricultural development are showing low levels of development. Such districts have been generally found in plateau region of the state where relief and the environmental conditions are not favorable for the development of infrastructure and also agricultural development. Therefore it can be said that the availability of infrastructure in themselves is not important for agricultural development. On the contrary these should be well correlated with each other and

should have interdependent relationships among them . Meaning thereby agricultural development should through more demand for infrastructure and development in infrastructure should lead to functional and structural change for the development of agriculture. To assess the impact of infrastructure on development of agriculture it is essential to work out the interrelationship among different indicators of infrastructure development.

5.2 Interrelationship between indicators of infrastructure development

For this purpose correlation matrix was worked out with the following results. Therefore, it can be say that the availability of infrastructures are not important only for agricultural development while it should be well correlate with each other for agricultural development.

Correlation matrix analysis between infrastructure to infrastructure (1980-81):

1. The value of r =0.81 between A1 and A2 i.e number of pumpsets energized per thousand of net irrigated area and number of distribution transformers per thousand hectares of net sown area respectively shows that these have positive correlation. It maybe so because both need energy to run .Thus, area where the supply of energy is assured there both indicators show better performance.
2. This can be positive correlation between A2 and A3 i.e. number of distribution transformers per thousand hectares of net sown area and percentage of village electrified relatively with the value of r =0.58.
3. Lack of statistical significance between A4 (number of bank offices of SCBs in rural areas per lakh of rural population) and all other variables indicates that in Bihar banks have failed to contribute significantly in the infrastructure development .
4. However , whenever the loans are available the farmer have used it for the purpose of development of assured irrigation like pumpsets, transformers and rural electrification. This can be concluded so due to positive correlation between A2 (number of distribution transformers per thousand hectares of net sown area) and A3 (percentage of village electrified) with A5 (outstanding credit in terms of Rs per agricultural worker) .
5. There is high correlation between A5 (outstanding credit in terms of Rs per agricultural worker) and A6 (outstanding credit in terms of Rs per hectare of gross

Table 5.1 : Correlation between Infrastructure and Infrastructure in Bihar 1980-81

INDICATORS		pump A 1	trans A 2	elec_vill A 3	bank offi A 4	credit_rs A 5	credit_w A 6	Fer_Con A 7	GIA_GSA A 8	Trac_GSA A 9
PUMP (A 1)	Pearson Correlatio	1.00	0.81**	0.19	0.16	0.12	0.09	-0.08	0.00	-0.20
	Sig. (2-tailed)	.	0.00	0.29	0.38	0.51	0.61	0.68	1.00	0.28
TRANS (A 2)	Pearson Correlation		1.00	0.58**	0.07	0.44*	0.40*	0.23	0.33	-0.03
	Sig. (2-tailed)		.	0.00	0.72	0.01	0.02	0.22	0.07	0.86
elec_vill (A 3)	Pearson Correlation			1.00	0.05	0.51**	0.50**	0.63*	0.72**	0.32
	Sig. (2-tailed)			.	0.81	0.00	0.00	0.00	0.00	0.08
bank offices(A	Pearson Correlation				1.00	-0.14	-0.12	-0.21	0.06	-0.19
	Sig. (2-tailed)				.	0.45	0.52	0.26	0.76	0.29
credit_rs (A 5)	Pearson Correlation					1.00	0.99**	0.38	0.24	0.36
	Sig. (2-tailed)					.	0.00	0.03	0.19	0.05
credit_wor (A 6	Pearson Correlation						1.00	0.39	0.27	0.41*
	Sig. (2-tailed)						.	0.03	0.14	0.02
FER_CON (A 7	Pearson Correlation							1.00	0.71**	0.57**
	Sig. (2-tailed)							.	0.00	0.00
GIA_GSA (A 8)	Pearson Correlation								1.00	0.53**
	Sig. (2-tailed)								.	0.00
TRAC_GSA (A	Pearson Correlation									1.00
	Sig. (2-tailed)									.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlatión is significant at the 0.05 level (2-tailed).

sown area) with value of r =0.99 is a case of multi-co linearity. However, credit per workers once again shows positive relationship with transformers and electrified villages.

6. There is positive correlation between A7 (fertilizer consumption in kgs per hectares of gross sown area) and A8 (gross irrigated area as a percentage of gross sown area) with a value of r =0.71 and between A7 and A9(number of tractors per thousand hectares of gross cropped area with a value r =0.57 shows that irrigation is prerequisite for modernization of agriculture in Bihar .
7. There is positive correlation between A8 and A9 with a value r=0.53 indicates that with modernization there is possibility of increased gross sown area in the state.12

Correlation matrix analysis between infrastructure to infrastructure (1990-91):

The situation seem to have changed from 1980-81 to 1990-91.The understand the nature of the following correlation have been worked out .

1. The correlation between A1 and A2 is positive with value of r=0.77.It may be so because both need energy to run .This show that district that have assured supply of energy have more number of pumpsets.
2. There is positive correlation between A2 and A5 with value of r =0.62.It shows that credit plays an important role in the popularization of transformers.
3. There is positive correlation between A3 and A7 with value of r =0.55. Once again it is clear that credit is crucial in the modernization of agriculture in the state.
4. Lack of statistical significance relationship between number of bank offices of SCBs in rural areas per lakh rural population (A4) and all other variables indicates that in Bihar banks have failed to contribute in the significantly in the infrastructure development.
5. There is high positive correlation with value of r =0.84 between A5 and A6 is a case of multi-colinearity however A6 once again show positive relationship with fertilizer consumption and tractors with r value of 0.48 and 0.69 respectively.
6. There is positive correlation between A7 and A8 with value r=0.67 .It shows that irrigation is prerequisite of modernization of agriculture in Bihar .

From the above discussion it is clear that the interrelationship between different indicators of infrastructure in Bihar haven't changed significantly.

Table 5.2 : Correlation between Infrastructure and Infrastructure in Bihar 1990-91

INDICATORS		pump A 1	trans A 2	elec_vill A 3	bank offi A 4	credit_rs A 5	credit_w A 6	Fer_Con A 7	GIA_GSA A 8	Trac_GSA A 9
PUMP (A 1)	Pearson Correlatio	1	0.77**	-0.18	0.26	0.34	0.11	-0.34	-0.29	-0.03
	Sig. (2-tailed)	.	0.00	0.33	0.16	0.06	0.54	0.06	0.12	0.87
TRANS (A 2)	Pearson Correlation		1.00	0.13	0.09	0.62**	0.42*	0.12	0.04	0.18
	Sig. (2-tailed)		.	0.50	0.63	0.00	0.02	0.52	0.82	0.33
elec_vill (A 3)	Pearson Correlation			1.00	-0.29	0.06	0.21	0.55**	0.54**	0.13
	Sig. (2-tailed)			.	0.11	0.74	0.25	0.00	0.00	0.48
bank offices(A	Pearson Correlation				1.00	0.05	0.06	-0.40	-0.17	0.01
	Sig. (2-tailed)				.	0.79	0.74	0.02	0.37	0.95
credit_rs (A 5)	Pearson Correlation					1.00	0.84**	0.21	-0.04	0.59**
	Sig. (2-tailed)					.	0.00	0.25	0.83	0.00
credit_wor (A 6	Pearson Correlation						1.00	0.48*	0.29	0.69**
	Sig. (2-tailed)						.	0.01	0.12	0.00
FER_CON (A 7	Pearson Correlation							1.00	0.67**	0.42*
	Sig. (2-tailed)							.	0.00	0.02
GIA_GSA (A 8)	Pearson Correlation								1.00	0.25
	Sig. (2-tailed)								.	0.17
TRAC_GSA (A	Pearson Correlation									1.00
	Sig. (2-tailed)									.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Correlation matrix analysis between infrastructure and agricultural development (1980-81):

1. There is positive correlation between B1 (agricultural productivity in terms of Rs per agricultural workers) and A9 (number of tractors per thousand hectares of gross cropped area) with a value of r =0.61.It shows that technical infrastructure like tractors is very effective for the high productivity.
2. B1 also shows positive correlation with A7 and A8 with a value of r=0.56 and r=0.58 respectively.
3. B2 (agricultural productivity in terms of Rs per hectare gross sown area) shows positive correlation with A7 (fertilizer consumption in terms of kgs per hectare of gross sown area)of value r=0.58 .This shows that fertilizer seems to have very strong relationship with productivity .Areas that have a more consumption of fertilizers have recorded high productivity .
4. The correlation between B3 (cropping intensity) and A9 shows positive relationship with value r =0.53.This show that tractors plays a major role in increasing the cropping intensity which result to agricultural development.

Correlation matrix analysis between infrastructure and agricultural development (1990-91):

The situation seem to have changed in the relation between infrastructure and agricultural development from 1980-81 to 1990-91.There are following correlation have been worked out:

1. There is positive correlation between B1 and B2 with the value of r =0.53.It means irrigation is must of one wants to improve agricultural productivity.
2. B1 also shows the positive correlation with A7 with value r=0.50.
3. There is positive correlation between B2 and A7 with value r=0.68.This shows that use of fertilizers is also crucial is improving both per worker and per hectare productivity.
4. B2 also shows the positive correlation with A3 with value r=0.57 and A8 with value r= 0.60.
5. B3 shows positive correlation with A7 with value r=0.59.It shows that fertilizers are helpful to increase cropping intensity of the state.

Table 5.3 : Correlation between Infrastructure and Agricultural Development in Bihar 1980-81

INDICATORS		pump A 1	trans A 2	elec_vill A 3	bank offi A 4	credit_rs A 5	credit_w A 6	Fer_Con A 7	GIA_GSA A 8	Trac_GS/ A 9	RsAg_W_ B 1	Rsha B 2	Crp_Int_ B 3
PUMP (A 1)	Pearson Correlatio	1.00	0.81**	0.19	0.16	0.12	0.09	-0.08	0.00	-0.20	-0.20	-0.25	-0.34
	Sig. (2-tailed)	.	0.00	0.29	0.38	0.51	0.61	0.68	1.00	0.28	0.28	0.17	0.06
TRANS (A 2)	Pearson Correlation		1.00	0.58**	0.07	0.44*	0.40*	0.23	0.33	-0.03	-0.11	-0.10	-0.12
	Sig. (2-tailed)		.	0.00	0.72	0.01	0.02	0.22	0.07	0.86	0.56	0.61	0.53
elec_vill (A 3)	Pearson Correlation			1.00	0.05	0.51**	0.50**	0.63*	0.72**	0.32	0.25	0.28	0.35
	Sig. (2-tailed)			.	0.81	0.00	0.00	0.00	0.00	0.08	0.17	0.13	0.06
bank offices(A	Pearson Correlation				1.00	-0.14	-0.12	-0.21	0.06	-0.19	-0.05	-0.18	-0.19
	Sig. (2-tailed)				.	0.45	0.52	0.26	0.76	0.29	0.78	0.34	0.29
credit_rs (A 5)	Pearson Correlation					1.00	0.99**	0.38	0.24	0.36	0.02	0.16	0.20
	Sig. (2-tailed)					.	0.00	0.03	0.19	0.05	0.92	0.38	0.28
credit_wor (A 6	Pearson Correlation						1.00	0.39	0.27	0.4	0.09	0.16	0.22
	Sig. (2-tailed)						.	0.03	0.14	0.02	0.64	0.39	0.24
FER_CON (A 7	Pearson Correlation							1.00	0.71**	0.57	0.56**	0.58**	0.30
	Sig. (2-tailed)							.	0.00	0.00	0.00	0.00	0.11
GIA_GSA (A 8)	Pearson Correlation								1.00	0.53*	0.58**	0.31	0.34
	Sig. (2-tailed)								.	0.00	0.00	0.09	0.06
TRAC_GSA (A	Pearson Correlation									1.00	0.61**	0.40*	0.53**
	Sig. (2-tailed)									.	0.00	0.02	0.00
RSAG_W_ (B 1	Pearson Correlation										1.00	0.42*	0.30
	Sig. (2-tailed)										.	0.02	0.10
RSHA (B 2)	Pearson Correlation											1.00	0.37*
	Sig. (2-tailed)											.	0.04
CRP_INT_ (B 3	Pearson Correlation												1.00
	Sig. (2-tailed)												.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

1990-91

Table 5.4: Correlation between Infrastructure and Agricultural Development in Bihar 1990-91

INDICATORS		pump A 1	trans A 2	elec_vill A 3	bank offi A 4	credit_rs A 5	credit_w A 6	Fer_Con A 7	GIA_GSA A 8	Trac_GS/ A 9	RsAg_W_ B 1	Rsha B 2	Crp_Int_ B 3
PUMP (A 1)	Pearson Correlatio	1	0.77**	-0.18	0.26	0.34	0.11	-0.34	-0.29	-0.03	-0.14	-0.42	-0.44
	Sig. (2-tailed)	.	0.00	0.33	0.16	0.06	0.54	0.06	0.12	0.87	0.46	0.02	0.01
TRANS (A 2)	Pearson Correlation		1.00	0.13	0.09	0.62**	0.42*	0.12	0.04	0.18	0.10	-0.12	-0.16
	Sig. (2-tailed)		.	0.50	0.63	0.00	0.02	0.52	0.82	0.33	0.61	0.53	0.40
elec_vill (A 3)	Pearson Correlation			1.00	-0.29	0.06	0.21	0.55**	0.54**	0.13	0.24	0.57**	0.39*
	Sig. (2-tailed)			.	0.11	0.74	0.25	0.00	0.00	0.48	0.19	0.00	0.03
bank offices(A	Pearson Correlation				1.00	0.05	0.06	-0.40	-0.17	0.01	0.02	-0.18	-0.52
	Sig. (2-tailed)				.	0.79	0.74	0.02	0.37	0.95	0.93	0.34	0.00
credit_rs (A 5)	Pearson Correlation					1.00	0.84**	0.21	-0.04	0.59**	-0.01	0.15	-0.19
	Sig. (2-tailed)					.	0.00	0.25	0.83	0.00	0.96	0.41	0.31
credit_wor (A 6	Pearson Correlation						1.00	0.48*	0.29	0.69**	0.35	0.48*	0.07
	Sig. (2-tailed)						.	0.01	0.12	0.00	0.05	0.01	0.73
FER_CON (A 7	Pearson Correlation							1.00	0.67**	0.42*	0.50**	0.68**	0.59**
	Sig. (2-tailed)							.	0.00	0.02	0.00	0.00	0.00
GIA_GSA (A 8)	Pearson Correlation								1.00	0.25	0.53**	0.60**	0.38*
	Sig. (2-tailed)								.	0.17	0.00	0.00	0.03
TRAC_GSA (A	Pearson Correlation									1.00	0.13	0.51**	0.16
	Sig. (2-tailed)									.	0.48	0.00	0.38
RSAG_W_ (B 1	Pearson Correlation										1.00	0.40*	0.47*
	Sig. (2-tailed)										.	0.02	0.01
RSHA (B 2)	Pearson Correlation											1.00	0.51**
	Sig. (2-tailed)											.	0.00
CRP_INT_ (B 3	Pearson Correlation												1.00
	Sig. (2-tailed)												.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

In the end it can be concluded that though infrastructure and agriculture development are complementary to each other yet it is highly affected by physical, social ,and economic factors .It is not necessary that all the infrastructure have same effect on the agricultural development .Some infrastructure have a greater effect than other infrastructure on agricultural development .The selected indicators of infrastructure and agricultural development in this study has shown variation in the association of each other .Some infrastructure are highly associated with each other e.g outstanding agricultural credit(Rs) per hectares gross sown area and outstanding agricultural credit (Rs) per agricultural workers is positively associated with the correlation value 0.99 and 0.85 in 1980-81 and 1990-91 respectively .Some infrastructure show negatively association with each other i.e in the case of number of pumpsets energized per thousand hectares of net area irrigated and the fertilizer consumption (kgs) per hectares gross sown area. Such conditions is also found in the case of infrastructure and agricultural development .

The discussion revealed that out of nine indicators of agricultural infrastructure only three infrastructure are highly associated with agricultural development viz. fertilizers, irrigation, and tractors.

Therefore, it can be said that many variations has been found in the association of infrastructure and agricultural development

To conclude the foregoing discussion it can be stated that in Bihar development of agriculture has shown positive response to modern rural agricultural infrastructure. If proper development of infrastructure is carried in Bihar it can come up strongly in term of agricultural development. Districts that have recorded high percentage of village electrified higher irrigation more fertilizer consumption and more credit available have also recorded higher production of land and worker.

SUMMARY AND CONCLUSIONS

Agriculture is the source of civilization of mankind as well as the primary sector of the economy. In India, agriculture is the main stay of about 70 percent of the total workforce and plays a major role in the Indian Economy. Besides most favorable climatic conditions, Indian agriculture is not well developed. Some developments have occurred in this sector in the last three decades particularly with the onset of 'green revolution' in India. This was based on use of package technology of irrigation, HYV seeds, fertilizers consumption starting from 1966-67.However it was hardly above some major limitation. One of the most significant one but it also brought in large scale regional disparities. Some regions highly benefited by this revolution while some regions remain unaffected or gained marginal benefits. Bihar is also one of these regions. Through, Bihar's economy revolves around this sector and it provides livelihood forever 80 percent of its people, yet it continues to be backward as compared to other states of India. However due to some technological innovations, this sector has been shown some symptoms of development in recent past. But due to physical, social and economical variation among the districts of the state there are disparities found in the diffusion and availability of such technological innovations or agricultural infrastructure in the state. This has seriously hampered the disparities of agricultural development among the districts.

United Bihar shares only 5.30 percent geographic of the country while it contributes 10.60 percent population of the country as 2001 census. Physiographically , the state is a combination of plains, hills and plateau. About 83.64 percent population of the state resides in the rural areas. The population density is higher in the plain regions of the state and the hills and plateau region are sparsely populated.

Out of 173 lakh hectare of the total geographical area about 44.50 percent is identified as net sown area. About 30.46 per cent of the net sown area is irrigated. The cropping intensity of the state was around 134.08 percent during 1990-91 and average size of land-holding in the state was 0.93 ha. during the same period.

There was disproportionate distribution of agricultural infrastructure in the state. There were 54.08 pumpsets are energized per 1000 hectares of net area irrigated during 1980-81.It increased by 49 percent during 1980-81 and 1990-91 and became 110.3 pumpsets energized per 1000 hectares of net area irrigated. District Dhanbad has high pumpsets energizer in the state with 1409.47 per 1000 hectares of net irrigated area during 1990-91 while districts from the north Bihar plain and north east Bihar plains the ratio was below 90, which show highly disparities in distribution of pumpsets.

During 1980-81, there was 2.65 transformers per 1000 hectares of net sown area in the state which increased upto 5.74 during 1990-91 once again. District Dhanbad had higher share of this infrastructure in the state with 21.47 while other districts less than 15 of the same..

There were 27.32 percent villages electrified during 1980-81 which became 58.49 percent during 1990-91. In the districts of the plateau region, the ratio of electrified village was below 60 percent while districts in the plains regions, have more than 60 percent village electrified.

There were 1.78 officer of SCBs in rural area per lakh rural population during 1980-81. It increased upto 4.91 during 1990-91. Singhbhum district has high concentration of this facility with 7 and at the other extreme was district Vaishali which had only 0.24 offices per lakh rural population..

There was Rs 51.87 of outstanding agricultural credit are available at per hectare gross sown area in the state during 1980-81 which became 905-67 Rs. During 1990-91. Patna districts has high availability of such infrastructure with Rs 2520 while Saharsa has only Rs 517.18 . This also indicate high levels of disparities among the districts .

Outstanding agricultural credit available at per agricultural workers in the state was Rs35.24 . It increased upto Rs459.23 during 1990-91. Once again district Patna had higher availability of this infrastructure with Rs1191.02 while district Saharsa have very low with Rs259.61.

Fertilizers consumption in the state has been 18.35 Kgs per hectares of gross sown area in the state during 1980-81 it increased upto 72.13 kgs during 1990-91. There was inter district disparities in the distribution of fertilizers in the districts The districts in the plateau regions have very low consumption of fertilizers i.e. below 40 Kgs while in the districts of bihar plains its ranges between 60 to 136 Kgs with some exception.

Bihar has reached potential of irrigation but the net irrigated area cultivation to be low .It has only 32.58 percent area irrigated as percentage of gross sown area in the state during 1980-81 which reached upto 39.98 percent during 1990-91. Plains regions has very percentage of gross irrigated area.It ranges between 19.63 percent and 82.22 percent in the plain and it has been below 26 percent in the plateau region.

There were 1.31 tractors has been available at per 1000 hectares of gross sown in the state during 1980-81 .It reached upto 5.70 during 1990-91. Patna district has been shown very high concentration of such infrastructure facilities in the state with 17.59 while Sitamarhi has only 0.11 tractors per 1000 hectares of gross sown area.

Therefore, it can be said that agricultural infrastructure has been increased in the state over the years but inter regional disparities have persisted.

The composite index value of the selected infrastructure shows the concentration of agricultural infrastructure among the districts. This index shows that the districts in the north and south Bihar plains have high concentration of agricultural infrastructure while districts from the plateau region are backward in this regard .Dhanbad districts is perhaps the one exceptional district where concentration of such infrastructure is high.

The three indicators of agricultural development has been shown the level of agricultural development in the state as well as its districts.

Agricultural productivity per agricultural workers was Rs745.54 in the state during 1980-81 which increased upto Rs1373.76 during 1990-91. In the case of agricultural productivity per hectares gross sown area, it was Rs2243.38 during 1980-

81 which became Rs5812.76 during 1990-91. Cropping intensity of the state was 134.08 percent; it became 136.13 percent during 1990-91. The study of the above indicators of the agricultural development has shown that plain regions has high develop agriculture as compared to plateau regions. It shows narrowing down the disparities in agricultural development in the state.

The analysis of the composite index of the indicators of agricultural infrastructure and agricultural development has reveals four points –

i. districts with high concentration of agricultural infrastructure are also the districts of high agricultural development eg. Patna, Saran, Begusarai etc.

ii. Districts with high concentration of agricultural infrastructure are backward in agricultural development. e.g. Dhanbad, Bhagalpur etc.

iii. A district with low concentration of agricultural infrastructure has high level of agricultural development. e.g. Gopalganj, Siwan, Muzaffarpur etc. and lastly.

iv. Districts with low concentration of agricultural infrastructure have also the low level of agricultural development. eg. All the districts in the plateau region except Dhanbad.

From the above discussion, it revealed that the concentration of agricultural infrastructure in any region is only a necessary condition for agricultural development to achieve the same on sustained bases proper response from physiography , social and economic factors is equally important.

The study of the correlation between agricultural infrastructure and agricultural development of the state has revealed that some infrastructures are highly correlated with other particular infrastructure. If one infrastructure is missing, other cannot perform well. It has also been shown that out of nine selected indicators of agricultural infrastructure, only three infrastructures, electricity, irrigation and fertilizer consumption, plays a major role in agricultural development. Therefore it can be said that, the districts which are develop in such three infrastructures, are also the districts of developed agriculture.

The overall conclusion of the study is reveals that there is uneven distributions of agricultural infrastructure in the state which are the results of variation in relief,

social and economic condition of the state. These caused uneven agricultural development among the districts of the state. Besides this, infrastructure plays a major role in the level of agricultural development in Bihar. Bihar has high potential for the development of agriculture. Use of appropriate infrastructure at appropriate space and time may contribute in faster and balanced development in the state.

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APPENDIX-I

Table-2 : Total Main Workers,Cultivators and Agricultural Labourers In Bihar

DISTRICTS	1980-81				1990-91			
	Total Main Worker	Percentage of agricultural workers cul.	ag. Lab.	total	Total Main Worke	Percentage of agricultural workers cul.	ag. Lab.	total
1.Champaran(West	648389	36.33	51.53	87.87	772050	34.58	54.58	89.16
2.Champaran(East)	734424	42.72	45.94	88.66	904738	40.34	49.72	90.06
3.Gopalganj	353134	63.49	25.97	89.46	440398	58.83	29.97	88.80
4.Siwan	410471	61.90	22.50	84.40	499441	58.40	25.30	83.70
5.Saran	486291	53.61	27.86	81.47	606607	50.39	31.24	81.63
6.Sitamarhi	560681	39.50	48.81	88.31	684030	38.75	48.86	87.61
7.Muzaffarpur	663677	39.89	41.06	80.96	823341	39.77	42.20	81.97
8.Vaishali	419623	49.23	34.24	83.47	540062	47.15	36.42	83.57
9.Madhubani	656016	42.30	46.22	88.52	839179	44.36	44.18	88.54
10.Darbhanga	550319	37.17	44.58	81.74	700250	38.11	45.50	83.61
11.Samastipur	584818	40.33	42.33	82.66	730001	40.07	42.62	82.69
12.Begusarai	411086	32.87	47.41	80.28	504817	33.96	46.53	80.49
13.Saharsa	1016829	40.84	48.40	89.23	1267653	44.10	47.19	91.28
14.Purnea	1231895	36.27	51.35	87.62	1515743	37.15	53.11	90.26
15.Katihar	469034	34.06	49.47	83.54	584916	35.73	50.42	86.15
16.Bhojpur	607070	41.87	37.19	79.06	731076	40.58	39.79	80.37
17.Rohtas	659114	43.95	37.23	81.18	805153	42.66	40.44	83.10
18.Aurangabad	342952	46.26	35.93	82.19	431205	45.84	38.31	84.15
19.Patna	834137	28.53	31.04	59.57	979769	27.99	33.86	61.85
20.Gaya	965661	43.04	38.84	81.88	1179136	42.27	41.30	83.57
21.Nalanda	494315	39.80	41.81	81.61	624460	39.45	43.80	83.24
22.Nawada	340715	49.40	36.22	85.62	412906	50.58	36.28	86.86
23.Munghyr	989740	41.10	40.18	81.28	1247473	39.88	42.97	82.85
24.Bhagalpur	777062	38.56	41.42	79.98	970369	39.23	43.63	82.85
25.Hazaribagh	627124	49.94	17.23	67.17	813076	49.34	20.17	69.50
26.Giridih	478199	56.38	14.61	70.99	622692	54.88	17.86	72.74
27.Santhal Pargana	1227955	59.62	20.86	80.48	1537426	59.22	23.67	82.90
28.Dhanbad	595906	18.22	7.62	25.84	700083	19.59	9.44	29.04
29.Palamu	620381	48.36	36.71	85.07	754459	48.16	37.55	85.72
30.Ranchi	1059777	61.48	14.23	75.71	1257768	63.69	12.63	76.32
31.Singhbhum	936333	40.97	21.62	62.59	1138762	43.57	22.09	65.66
BIHAR	**20753128**	**43.57**	**35.50**	**79.07**	**25619038**	**43.58**	**37.13**	**80.71**

cul.= cultivators
ag. Lab.= agricultural labourers

Souces: Census of India, 1981 and 1991

APPENDIX: 2

Table8 : Percentage of Irrigated Area in Bihar

DISTRICTS	Net Sown Area Irrigated (%		Groth Rate(%)	Gross Sown Area Irrigated (%)		Groth Rate(%)
	1980-	1990-91	1981-91	1980-81	1990-91	1981-91
1.Champaran(West)	43.51	36.11	-17.02	41.33	33.97	-17.82
2.Champaran(East)	30.54	43.62	42.84	26.47	38.26	44.51
3.Gopalganj	56.40	79.99	41.84	44.47	45.13	1.48
4.Siwan	58.33	70.37	20.64	41.80	46.89	12.19
5.Saran	55.01	60.68	10.31	38.00	42.66	12.28
6.Sitamarhi	13.69	23.69	73.09	11.77	19.63	66.75
7.Muzaffarpur	27.59	36.19	31.14	21.83	27.72	27.02
8.Vaishali	32.84	58.57	78.35	24.11	39.37	63.27
9.Madhubani	12.16	21.15	74.03	12.68	20.31	60.20
10.Darbhanga	15.35	39.24	155.70	13.68	30.24	121.11
11.Samastipur	29.51	46.92	59.01	27.25	36.03	32.20
12.Begusarai	38.14	73.46	92.61	28.57	45.33	58.67
13.Saharsa	33.32	43.99	32.01	27.76	38.68	39.31
14.Purnea	12.31	24.37	98.03	14.63	26.23	79.25
15.Katihar	18.29	29.54	61.46	19.26	32.16	66.94
16.Bhojpur	76.73	82.36	7.34	68.80	97.90	42.29
17.Rohtas	71.42	88.35	23.71	72.80	82.22	12.94
18.Aurangabad	82.65	91.32	10.50	65.09	72.40	11.24
19.Patna	70.00	60.96	-12.92	59.91	63.87	6.61
20.Gaya	81.87	83.08	1.49	83.49	79.66	-4.59
21.Nalanda	96.85	88.07	-9.07	82.24	78.80	-4.18
22.Nawada	97.84	88.29	-9.76	74.53	78.74	5.66
23.Munghyr	43.38	53.42	23.15	35.80	47.30	32.14
24.Bhagalpur	45.34	51.04	12.55	40.78	49.31	20.91
25.Hazaribagh	9.33	10.99	17.78	9.56	13.15	37.62
26.Giridih	6.62	6.10	-7.86	8.30	7.48	-9.92
27.Santhal Pargana	8.93	6.24	-30.07	9.99	7.52	-24.70
28.Dhanbad	1.91	1.26	-33.86	2.96	1.51	-49.06
29.Palamu	27.45	23.31	-15.08	22.15	25.59	15.49
30.Ranchi	4.73	4.90	3.46	5.58	5.10	-8.59
31.Singhbhum	3.95	3.44	-13.00	4.22	3.83	-9.41
BIHAR	**35.52**	**30.46**	**-14.23**	**32.58**	**39.98**	**22.74**

Sources:Indian Agriculture Statistics, 1980-81 and 1990-91