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AGRICULTURAL PRODUCTIVITY IN SOUTH BIHAR PLAIN : A SPATIAL ANALYSIS

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ABSTRACT: Discussed in the paper is the agricultural productivity in South Bihar, as demonstrated by the coefficient of agricultural productivity. The paper reviews some of the indices usually applied to measure agricultural productivity and chooses one that suits South Bihar. The spatial variation in productivity worked out on the basis of *anchal* as an areal unit is explained in terms of physical as well as human parameters that govern crop yield.

Agriculture being the backbone of the Indian economy, concerted efforts have been made for its improvement in the post independence period. Unfortunately, the fruits of various development schemes have not been shared equally by all regions, so that a few growth points accounting for major grains have emerged while large areas continue to wallow in stagnation.

Bihar is one of the states which are worst affected by the natural phenomena of droughts, famines and floods. Inspite of the various development measures, the problem still persists and the state is less than self-sufficient in food-supply. Agricultural backwardness is the main cause of poverty and overall economic backwardness of South Bihar Plain. Therefore, special attention needs to be given to the agricultural front to meet the growing demand of food. The study of agricultural imbalances at different levels is essential to find suitable conditions for balanced regional agricultural development.

The measurement of productivity has engaged the attention of agricultural scientists, economists, and geographers, alike, both abroad and in India. Agricultural productivity is a multidimensional concept based primarily on technological advancement and organisational set-up of production. These factors in turn affect the relative productivity of various regions. The regional variations in productivity and its measurement, therefore, form an important theme of studies in agricultural geography.. This provides the vital dues to the direction in which further agricultural investment may be made. Agricultural productivity, as a concept, means the degree to which the man-made framework is able to exploit the physical resources of an area for the purpose of agricultural product (Sarma, 1965). It is conceptualised as the ratio of output to all inputs used in the production process. The computation of such a ratio, hence, involves the problem of aggregating a variety of output and input into single indexes. This aspect of derivation of productivity indexes is the major source of disagreement (Chritensen, 1975). In this respect, Geographers confront the additional problem of lack of data at suitable scale in spatial analysis of agricultural productivity. Therefore, they have used either average crop yields or some com-

bination of crop yields and area occupied by crops to measure agricultural productivity (Dayal, 1984). Because their efforts, so far, are confined to the analysis of partial agricultural productivity.

This paper attempts to examine the nature and charateristics of agricultural productivity imbalances in the South Bihar Plain. It provides an appropriate conceptual base for understanding regional imbalance in agricultural productivity and will help the planners in understanding, controlling and ultimately, tackling the problem more efficiently to improve the productivity.

Data and Methodology:

The study uses mainly secondary data which have been obtained through government and quasi-government publications and the results are also analysed with the help of field survey data. An anchal is used as a unit of study. 146 anchals have been selected for tne measurement of productivity. The nature of agricultural output is based on 16 major crops: rice, wheat, maize, ragi, gram, tur, rape seed and mustard, sesamum, tisi, khesari, urad, moong, lentil (masoor), sugarcane, potato and onion. Together these account for more than 80 per cent of the total cropped area.

Because agricultural output fluctuates annually, a three-year average of the output of each crop has been computed for the triennium 1980-81 to 1982-83. To aggregate the outputs of 16 crops, these are converted into money value by using average state level prices of 1980-81 to 1982-83. Although data for area and the production of selected crops are available for the most recent year, to minimize errors stemming from temporal inconsistency it was decided to use production data only for the average centered on 1981–82. Despite certain imperfections resulting from using money value, the reliance on price data cannot be avoided (Kravis 1976, Connel and Lepton, 1977). Prices reflect the relative importance assigned to different crops. Thus, converting output into money value permits the relative importance of the cropping pattern to be taken into account.

Some writers have suggested that the conversion of money value of output is not so meaningful in subsistence agriculture and have converted various agricultural outputs into 'grain equivalents' of the most common grain consumed in the region (Buck 1937, Clark and Haswell, 1967). This procedure creates problems on the basis of calories or protien or energy as exchange values. Thus, it too is open to criticism. Several writers have used money value of output to analyse productivity changes in agriculture. A farm harvest prices for all major crops are available only at state level. Local prices are not available. Though the value of output at anchals might have been somewhat distorted but not as much as it would have been if state level average prices had been used. In this study the conversion of agricultural output into money value for making spatial comparisons was considered the most satisfactory of all the alternative available.

Productivity Measurement:

Here the index of land productivity (agricultural productivity per hectare) is used and defined as the money value of outputs of 16 crops per unit of area occupied by the crops and is given by the formula (Husain, 1976):

$$I_j = \frac{\sum_{i=1}^{n} y_{ij} C_{ij}}{a_{ij}} \div \frac{\sum_{i=1}^{n} Y_i C_i}{A_i}$$

Where

I_j = Index of agricultural productivity of jth unit,

Y_{ij} = Production of ith crop in jth unit,

n = Number of crops grown in jth unit

C_j and C_{ij} = Price of jth crop

Y_i = Production of jth crop in the entire region

A_i = Area under jth crop in the entire region.

Further the final computed values have been converted into productivity coefficient for finding the productivity with respect to the regional level. For this purpose, the following formula has been used (Enyedi, 1964):

$$\frac{Y}{Y_n} \div \frac{T}{T_n}$$

Where,

Y = the total yield of the selected crops in the unit area,

Y_n = the total yield of the crop on regional scale,

T = total crop area of the unit

T_n = total crop area on regional scale.

To explain the spatial patterns of regional imbalances in agricultural productivity in the South Bihar Plain, the obtained indexes are arranged in decending order and grouped into high, moderate, low, very low and extremely low categories.

The Study Area:

The South Bihar Plain which is a part of the Indo-Gangetic Plain lies between latitudes 24°30′N and 25°46′N and longitudes 83°20′E and 87°45′E, and is bounded by the river Ganga in the north, 150 metres contour line of the scarps of Chota Nagpur Plateau in the South, Rajmahal hills in the east and Uttar Pradesh in the west. It contains an area of 36,192 km² which constitudes 20.7 percent of the total area of Bihar. The region has a population of 19.9 million with a density of 533 persons per km² (1981). This is more than the average density of population in Bihar (402 persons per km²) and India (216 persons per km²). The region may be divided into two main physiographic units — the hilly area consisting of Kharagpur and Rajmahal hills in the east, and the vast plain of the river Ganga and the river Son in the west. It experiences a subhumid climate with the hot dry summer from March to May, the rainy season from June to October and the cold dry winter season from November to February. Rainfall varies from 800 mm to 1300 mm and is highly seasonal, variable and erratic. This considerably affects agriculture. The soil is by and large fertile alluvium. They are divided into Khadar and Bhangar groups. Khadar covers the flood plains in the vicinity of rivers while the Bhangar is the older alluvium and covers the upland tracts beyond flood limit in the valley flat. In general, the soil of the region is heavier and finer in texture. About 65 per cent of the total area is under cultivation, 6 per cent is covered by forest, groves and pastures, and the remaining 29 per

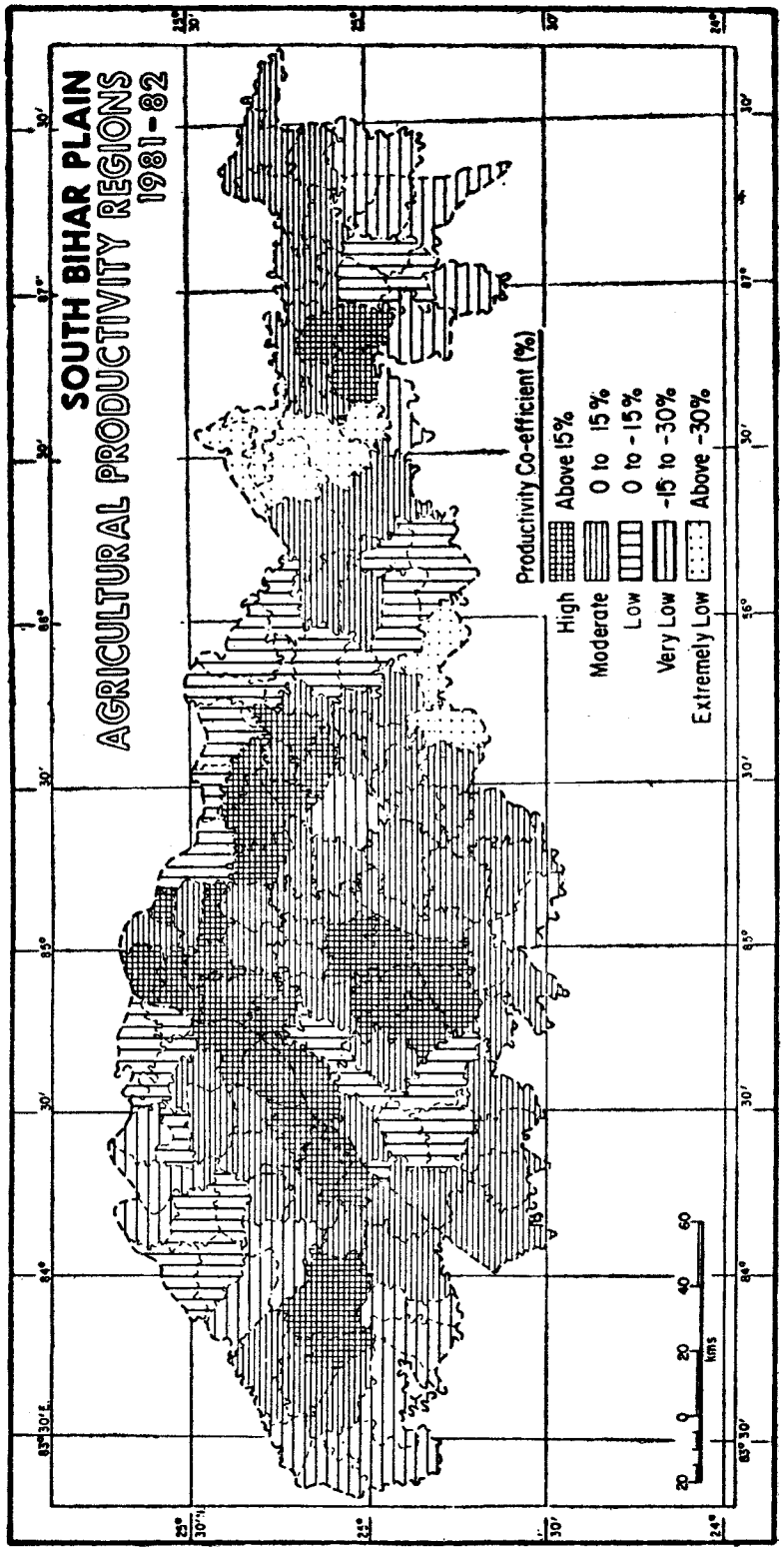
SOUTH BIHAR PLAIN
AGRICULTURAL PRODUCTIVITY REGIONS
1981-82
Productivity Co-efficient (%)
High
Above 15%
Moderate
0 to 15%
Low
0 to -15%
Very Low
-15 to -30%
Extremely Low
Above -30%
0
20
40
60
Kms

Fig. 1

cent of the total area is cultivable. The percentage of cultivated land varies greatly. The principal kharif crops are rice, maize, sugarcane, ragi, tur, moong and sesamum. The major rabi, crops are wheat, barley, gram, khesari, lentil, urad, peas, tisi, rapeseed and mustard, potato and onion.

Patterns of Agricultural Productivity:

Agricultural productivity in South Bihar Plain is relatively low. A cursory glance of Tabe 1 indicates that about 62 per cent anchals of the study area have productivity higher than the regional level. Out of this 21 per cent are placed in high productivity regions while 41 per cent have moderate productivity. The remaining 38 per cent have a productivity level below the regional average, with 19 per cent having low, 14 per cent very low, and 5 per cent extremely low productivity. Hence, it would be worthwhile giving a detailed account of each region.

TABLE — 1

Agricultural Productivity classes 1981-82

Productivity classes	Productivity Coefficient	No. of Anchals
High	>15	31
Moderate	0 to 15	60
Low	0 to — 15	28
Very Low	— 16 to — 30	20
Extremely Low	< — 30	7
Total		146

Source: Calculated by the author.

High Productivity Region:

The productivity in this region is 15 per cent higher than the regional level. There are thirty-one anchals (about 21 per cent of the total number of anchals) in this region. It forms four distinct homogeneous areas (Fig. 1). The major area covering fifteen anchals, lies in the Son valley stretching from central part of Rohtas district in the south to Patna district in the north. It runs almost parallel to the river Son. The continuity of this zone is interrupted by Nokha anchal in Rohtas district and Danapur and Phulwari anchals in extreme north in Patna district. All these three anchals form an island of medium productivity. The next region of high productivity comprises of seven anchals, viz., Hilsa, Chandi, Harnaut, Noorsarai, Rahui, Bihar Sharif and Asthawan. These anchals are located in the **Tal** physiographic region of Nalanda district. The third pocket of high productivity occurs in the central part of the region. It includes six anchals, viz., Gurua, Koch, Tekari, Makhdumpur, Bela and Gaya town. A small isolated pocket of high productivity is formed by only three anchals, viz., Sambhuganj, Shakhund and Amarpur and is located in the eastern part of the region in Bhagalpur district.

Variation in productivity is well marked within the various regions and also from one region to another depending upon characteristics of relief, slope, microclimate, drainage and soil as well as the level of diffusion of agricultural innovations. For example, within the high productivity region of Son valley, there are eight anchals in which productivity ranges from 31 to 98 per cent, while in seven anchals it is from 17 to 30 per cent higher than the regional average. The highest productivity is noticed in the area flanking both the Arrah canal and Patna canal. Evidently, the availability of irri-

gation water played the crucial role in raising the productivity but apart from this the fertile kewal soil, adequate rainfall (above 1050 mm). adoption of agricultural innovations by cultivators and the impact of capital city of patna) have not been less significant in this respect. Rural literacy, which is expected to expose farmers to new developments in agriculture, likewise appears to have high bearing on agricultural productivity. In the Bear village the percentage of literate to total population is quite high. It is about 42 per cent. It has good impact on agricultural productivity in this region. Sharecropping has little bearing on agricultural productivity. It is not widely practiced here; most of the cultivators are owners of the holding. For example, there are only 5 per cent cultivators who lend their land to share-croppers. In many of the villages traditional agricultural castes, viz., Kurmi, Koeri, Yadav are dominant in their demographic structure and in recent times even the non-agricultural castes, Rajput, Brahmins, Kayasth and others have enthusiatically taken over the agricultural pursuits and used their resources for modernising agriculture. Althouth it is mainly an area of canal irrigation, the cultivators have significantly adopted pump irrigation, high yielding variety and other inputs. The number of irrigation pumps for example, in the village Ekwari is 50 and the quantity of fertilizer consumed is 43 kg. per hectare. Approximately, 57 per cent of the cultivated area of the village is under high yielding variety of wheat, rice, sugarcane maize and other crops.

Another pocket comprises of seven anchals viz., Chandi, Rohugi, Bihar Sharif Asthawan, Noorsarai Hilsa and Harnaut with 78, 66, 42, 34, 22, 21 and 19 productivity coefficient respectively is located in the **Tal** physiographic area. The causes for high productivity coefficient of this pocket are slightly different from that of the Son valley region. Here, the fertile levee soil plays an important role in increasing the productivity. Due to siltation, every year the fertility of soil increases. The topographic features as well as the slope of the land in this pocket are equally significant to increase the fertility rate of the soil. In the Morhara and Meghra villages the soil rating index is 60 and 64 which is highest in the region. Moreover, the adequate rainfall (above 1000 mm) and availability of irrigation water have also played a significant role in raising the high productivity. The impact of urban places, local market as well as the spatial diffusion of innovations in rural areas among the cultivators have not been less significant in this respect. Literacy is also high in this area. In the Meghara village the percentage of literate to total population is more than 32 per cent. However, the high rate of soil fertility, adequate water supply alone does not satisfactorily explain the pattern of high productivity in this region but economic, social and technological variables also play a major role. The use of mechnisation, i.e., fertilizer, tractors, improved seeds to raise the productivity is more successful.

The next pocket of high productivity lies in the central part of the region comprising of six anchals in which the productivity ranges from 17 to 20 per cent higher than the regional average. Koch, Tekari and Gaya town anchal have 19 per cent of productivity, while Bela, Makhdumpur and Gurua record 17, 18 and 20 per cent respectively. The high productivity in these anchals is due to the diffusion of agricultural innovation among the farmers. After Green Revolution the introduction of fertilizer demanding high yield variety seeds opened a new era of agriculture in

this region and increased the fertilizer consumption. This has led to substantial increase in the yield per hectare of several crops as well as the intensity of cropping pattern. Apart from that a more convincing fact is an increase in population density and the degree of urbanisation which has direct relation with productivity. Boserup's (1965 and 1981) theory of population and agricultural change, therefore, contends that positive relationship exists between population density on the one hand and frequency of cultivation and level of technology on the other. There appears to be a good spatial accord between them. The impact of Gaya city on its north and western segment, (25-30 km) from Gaya, has not been less significant in this respect. In the Saren village about 15 km east Gaya city the literacy is more than 36 per cent of the total population. It has also positive correlation with agricultural productivity. In many of the villages the traditional agricultural castes, viz., Koeri, Kurmi, Yadav and others are exceptionally high in number and user their resources for developing the agricultural productivity. Although the soils in this pocket are very much affected by the hilly and terraced landforms in the eastern part of the city, the adoption of pump irrigation, use of high quantity of fertilizers, high yielding variety of seeds and other inputs have made this area one of high productivity.

A very small pocket of three anchals of high productivity lies in Bhagalpur district where Amarpur, Sambhuganj and Shahkund recorded 22, 18 and 16 per cent productivity higher than the regional average. The high productivity is caused by adequate rainfall above 1200 mm, fertile older alluvium with greyish yellow soil and the adoption of agricultural innovations. For example, in the Kathali village (Amarpur anchal) the farmers have significantly adopted the canal irrigation, higher number of pumping sets (47) as well as tractor (7) for high yield of crops. At the same time the literacy rate is also quite high. It records about 51 per cent of literate persons to the total population which appears to have high bearing on agricultural productivity. This pocket is not dominated by traditional cultivators but the adoption of innovation raised the interest in non-agricultural castes particularly Rajput, Brahmin and even Kayasth to use their resources for modernising the agriculture. The quantity of fertilizer consumed is 49 kg. per hectare, the highest amount in the region. Approximately, 60 per cent of the cultivated area of the village is under high yielding variety of rice, wheat, maize and sugarcane.

Moderate Productivity Region :

This region is very extensive and comprises of sixty anchals (about 41 per cent of the total anchals). The anchals having recorded productivity coefficient upto 15 per cent higher than the regional average have been included in this category. They are located in almost all the physiographic regions and form five distinct homogeneous units in the region (Fig. 10). A major unit of forty-one anchals is found in the central part of the region between Arrah canal in the west to Sakri canal in the east. The second pocket also comprises of ten anchals. It is found in the extreme north-eastern part of the region. The next pocket of four anchals lies in the central part of Munger district. A very small pocket of three anchals is found in the extreme north-western section of Rohtas district and one more isolated pocket of two anchals lies in the west of Patna in levee region.

The spatial variations in relief, slope, drainage and soil on the one hand and the diffusion of agricultural innovations together with the impact of urbanisation on the other, have marked the regional variations in moderate productivity region. For instance, a major pocket of forty-one anchals of moderate productivity lies between Arrah canal in the west and Sakri canal in the east. The continuity of this region is interrupted by the high productivity of Son valley in the west and central high productivity of Gaya region in the east. In between, there is a small island of low productivity stretching from south to north. Nevertheless, a majority of twenty-six anchals from south-west corner of Gaya to north-west part of Gaya including Nawada and southern part of Nalanda districts form a big pocket of moderate productivity region. Here the productivity range varies from 2 to 14 per cent higher than the regional average. The basic cause of their variations is low yield of crops which is either due to weather abnormalities or due to low level of technological and institutional advancement, i.e., lesser number of tractor, pumping sets, low quantity of fertilizer consumption, low quality of seeds and low literacy index. As a matter of fact, this pocket receives inadequate rainfall ranging between 775 mm. and 1170 mm. as well as very poor irrigation facilities. For example, in the village Laund (Sirdala anchal) only 47 per cent land is irrigated during the agricultural year, and the quantity of fertilizer consumed is 24 kg. per hectare (the lowest amount of the region's consumption). Literacy is also quite low in the area. In Shahabad village (Masauri anchal) and Laund village (Sirdala anchal) the percentage of literate to total population is about 28. In many of the villages share-cropping is widely practised because most of them are non-traditional cultivator castes, viz., Rajput, Brahmin and Kayasth.

On south-western margin of Son high productivity region, another pocket of fifteen anchals also forms a moderate productivity region. It includes anchals of Aurangabad, Rohtas and Bhojpur districts. The productivity range varies from 1 to 15 per cent higher than the regional scale. But the causes of its variation are numerous. Environmental factor plays an important role in this section. The southern part of the pocket is an area of great inequalities in physiography and consists of a succession of hilly terrain land of hard rocks. Most of the anchals, viz., Deo, Madanpur, Nabinagar, Kutumba, Dehri and Sasaram include the hills, hillocks and the extension of upland mass of Chota Nagpur hills. This type of land is relatively infertile. Agriculture is insignificant because the land is a part of foothill and eroded scarp soil which is generally poor in humus and nitrogenous content. Variability of rainfall is an other factor of equal significance. It is an area of less rainfall and maximum variability which ranges between 20 and 30 per cent. Due to hilly scarpment this pocket receives rainfall between 1000 and 1200 mm. but it drains rapidly due to the greater slope of the region. Ultimately, it does not help much the plant growth.

Technological and institutional factors have also played significant role in this respect. For example, in the Beri village (Madanpur anchal) the number of pumping sets and tractors is 29 and 2 only. Even these pumps are not functioning properly due to low water table and poor supply of electric power in rural areas. Moreover, this also affects the poor consumption of fertilizer (20 kg. per hectare) among the farmers. Literacy is another important factor which affects the agricultural productivity. It is zero

to five per cent in the rural areas, and between 10 and 20 per cent in and around the urban areas. However, it is not an area of agricultural farmer rather dominated by non-agricutural farmer particularly Rajput, Brahmin Bhumihar and so called upper castes in Bihar. They have always showed less interest in agriculture. Due to lack of capital and innovation, the sharecropping has not developed the agricultural productivity. This area is also less affected by high yielding variety programme in the region. On the northern part of this pocket the land is almost plain and fertile. It is an area of canal irrigation. But the land is not irrigated properly and adequately in time, because it is far away from the main canal. Ultimately, the yield rate has not increased. Since the area does not possess an important urban and market centre, farmers are less innovative. The low literacy rate, low size of family, low social position, and tenancy systems are also not less convincing factors for the moderate agricultural productivity in this pocket. For example, in the village Angra in Pero anchal (Bhojpur district) the literacy rate is only 20 per cent. This figure is also found in Satwan village in Nokha anchal (Rohtas district) within this moderate productivity zone. The tenancy system and sharecropping have also developed in these villages. The size of holding is very small. In Tarar village of Daudnagar anchal (Aurangabad district) it has only 2.2 hectares that is small size of holding.

Another area of moderate productivity lies in the north-eastern part of **levee** region. It includes ten anchals of Bhagalpur and Santhal Pargana district. It is bounded by river Ganga in the north, Rajmahal hills in the east and the foothills of Munger district in the west. In this pocket the productivity also varies from 1 to 15 per cent higher than the regional average. As regards other pockets of moderate productivity, it is an area of plain land topography where short-lived seasonal river chandan flows in hit-and-miss fashion. The land is very good and fertile. More or less, it is also an area of high rainfall (more than 1200 mm.) during the rainy season. Due to heavy rain and overflow of the river water, the river spreads new sheets of fertile sediments on the upper layer of soil. This process is repeated every year and, finally, it becomes an area of high silt deposits. This silt consists of newer alluvial soil and is suited for intensive cultivation of **bhadai** and rabi crops.

Due to the environmental constraints, the farmers have not used the technological equipment to develop the agricultural productivity in this area. For example, in the village Udhadih in Sultanganj anchal (Bhagalpur district) and Sudin village in Meharma anchal (Santral Pargana district), farmers have supplied 35 and 27 kg. of fertilizer per hectare and have significantly adopted pump irrigation (41 and 27 in number), high yielding variety and other inputs but the net result of productivity has come down below the regional productivity average. This clearly shows that the area is more influenced by physical than other factors.

Some small pockets comprising of three anchals each in Munger and Rohtas district and two anchals in Patna district are scattered in this region. In Munger district Lakhmipur, Lakhisarai and surajgarh have recorded 9, 5, and 3 per cent productivity respectively higher than the regional average. Within it, Lakhisarai and surajgarh anchals are highly affected by the flood water within levee region. Crops are highly affected by frequent flood water of the river Ganga. Sometimes farmers get high yield of crops

but often the crops are detroyed by flood water in mature and pre-mature stage. Therefore, the cultivators depend primaraly upon the natural factors which are beyond their control. In this respect, these anchals have low yield of crops even after using the high technological factors. In Lakhmipur anchal the situation is different. About half of the area of this anchal is affected by hilly and rough land form of Kharagpur hills. The soil is mixed with sand and rocks which is not suitable for agricultural crops. The technological and other improvement factors are also negligible.

In Rohtas district, the condition is some what different. It is an area of dryland where rainfall as well as irsigation water is insignificant. The annual rainfall is less than 800 mm., while the variability is between 25 and 35 per cent. The saline alkaline soils of old alluvium have not encouraged the yield of crops due to lack of water. Although it is an area of maximum tube-well irrigation, the water tabe is comparatively very low. The sample village — Gorasara in Ramgarh anchal has recorded very high productivity level at micro level. It supports that the farmers have a higher number of tube-wells (45), medium doze of fertilizer consumption and high percentage of literacy among farmers and other input factors for the high productivity of the region. While other villages have not the same kind of production but when they are added and averaged at anchal level, it falls in moderate productivity rank.

In Patna district, Danapur and Phulwari anchal have recorded 2 and 4 per cent higher productivity respectively than the regional average. These anchals have a higher level of technological advancement as well as environmental factors. It is a part of fertile levee land of **Diara,** where crop-combination and crop-rotation is the prime consideration. To increase the soil fertility all kinds of chemicals are used in these anchals. Therefore, the fertility of soil index is always maintained. More or less, this is an area of urban influence where percentage of literacy is comparatively high. Farmers have adopted pump irrigation, high Yielding Variety (H.Y.V.) and other inputs significantly. For example, in the sample village Bear in Phulwari anchal (Patna district), the soil rating index is 56. Literacy is quite high, viz., about 41 per cent of the total population. Technilogically, it is also an advanced area. There are 26 pump sets, 16 tractors available in this village. About 63 per cent of the total land is irrigated, and the consumption of fertilizer is about 38 kg. per hectare. About 70 per cent cultivators are engaged in agricultural activity. Moreover, the area is also dominated by Kurmi and Koeri agricultural castes. After all, this village has not been categorised in high productivity region because the major emphasis of these technological factors is given to grow the vegetables due to the impact of Patna urban centre and these crops are excluded from this study. That is why this anchal has not increased its productivity so far.

Low Productivity Region:

The anchals having recorded productivity 15 per cent below the regional average have been categorised under this region. Twenty-eight anchals (about 14 per cent of the total anchal) fall under this category. The spatial pattern of these anchals shows that they are distributed in five different areas of the region (Fig. 10). Twelve anchals stretching from north-eastern part of Patna district to the western part of Munger district form the major pocket. Another pocket of eight anchals is located in north-western part, while five anchals are also concentrated

in the west of Central Gaya high productivity region. A very small pocket of three anchals lies in the eastern part of Bhagalpur high productivity region.

The low productivity region of twelve anchals forms a compact ribbon belt in central levee area and extends towards the central dry land of western Munger district. Here, the productivity ranges between 2 and 15 per cent less than regional average. The productivity also varies among these anchals. There are eight anchals where productivity ranges from 10 to 15 per cent while in the remaining four anchals it is between 2 and 10 per cent. The causes of its variations are numerous. But the low productivity is the result of low yield of crops which is the manifestation of environmental constraints particularly the flood and poor soil (in the form of sand) in the region. The technological and other input factors are not used in this area due to uncertainty of flood. In the southern part of this pocket the conditions are different. It is an area of dryland where there is scarcity of water both through rainfall and irrigation. The maximum rainfall goes upto 1000 mm. which is poor from agricultural point of view. The water table is also quite low. Due to uncertainties of monsoon rains and water scarcity, Kharif crops suffer in the southern part. Rural literacy, which is expected to expose farmers to new developments in agriculture is lacking in this area. Here the pressure of population on land has resulted in very small holdings and high inputs of labour leading to poor productivity in the area. For example, in Amrath village in Jamui anchal (Munger district) the adoption of technological factors is not high because the literacy is quite low. Only 19 per cent of the total population is literate. The consumption of fertilizer is only 22 kg. per hectare, which is below the regional average. More or less, it is not dominated by traditional agricultural castes. The muslims, are dominating in this village, who have lesser concern with agriculture.

The next pocket of low productivity lies in north-western part of the Bhojpur district. It forms a contiguous belt consisting of eight anchals. Its continuity is interrupted by three very low productivity anchals in central part of this pocket. The north-eastern four anchals are ranging in productivity from 1 to 8 per cent below the regional average, while in other four anchals of western part it ranges from 1 to 14 per cent. The causes of its variation and low productivity are many but the important among them are the deterioration of soil fertility, soil erosion and the water scarcity. It is an area of very low rainfall and maximum variability from 20 to 35 per cent. Although there is considerable potential for irrigation development in this district, further expansion of it has not been done so far. Other sources of irrigation are also lacking. The fertilizer consumption is very poor. In northern part during the rainy season, Barhara, Koilwar and Arrah anchals are affected by flood water.

One more pocket of five anchals lies in the west of Gaya, high productivity region, and Son, medium productivity region. Here the yield level of all crops is low because the ratio of net irrigated land to sown area is comparatively low. The rest of the causes for low productivity are almost same but the efficiency has decreased in all respects. Three anchals located in the east of Bhagalpur high productivity region form another pocket. They are Dhuraiya, Rajaun and Barahat with 11, 14 and 15 per cent lower than the regional average productivity. The basic cause of its low productivity is erratic nature of monsoon rainfall. Due to the influence of Rajmahal

hill, the soil condition is also not good. It is mixed with Kankar and Sand which is not fertile. Agriculture is totally dependent upon rainfall. It is a single cropped area. Except rice no other crops are cultivated. Therefore, agriculture in this area suffers from uncertainties of monsoon rains resulting into frequent crop failures from droughts and floods.

Very low Productivity Region:

The region of very low productivity is in fact the continuation of low productivity. It ranges between 16 and 30 per cent less than regional average productivity coefficient. There are twenty anchals which are covered under this category. Figure 1 shows that these anchals are scattered in two different parts of the region: one lies in the north-eastern part of heavy rainfall area, and other in south-western drier part of the region.

Seven anchals of very low productivity lies in the north-eastern part bounded by the foothills of Rajmahal hills on the one hand, and the border of Chota Nagpur Plateau on the other. All these anchals consist of hard rocks with hilly terrain surface. They are not suited for intensive agriculture. Here cultivation is totally dependent upon rainfall. Due to heavy rains (Above 1300 mm) and hilly terrain landform a single crop (monoculture) cultivation is practiced. The yield level of rabi crops is quite low. Modern technological factors particularly the use of pumping sets, tractors, and fertilizers are relatively insignificant in this pocket.

The next zone of six anchals lies in the south-western part of Rohtas district adjacent to the Kaimur hills. In comparision to the eastern pocket this area is comparatively dry. There is a shortage of water for the cultivation of crops. During the rabi season, the crops are not satisfactorily grown due to dryness of the area, limited ground water and low technological development. The institutional or demographic constraints seriously restrict the use of technology in overcoming environmental inadequacies. The abject poverty of the toiling people in this part is one of the basic reasons of very low agricultural productivity. One of the sample villages Tekari in Chenari anchal (Rohtas district) also supports that the agricultural productivity is very low in this pocket because the fertility of soil is poor and its rating index is only 50. Hence, inspite of heavy monsoon rain (above 1300 mm. near plateau area), the yield level hardly increases. The dominant soil is Kewal which is useless without irrigation water in summer season. The fertilizer consumption is only 18 kg. per hectare in this village. Due to plateau escarpment the water table is quite low. There are 28 electric pump sets in the village, but they are not normally functioning properly due to power failure and even low ground water table. The government has introduced several development programmes but they have also partially failed at the lower unit of its policy. Literacy is supposed to be the base of technological advancement among the cultivators but it is also at the lowest level in this area. Tekari village has 21 per cent less than regional average of agricultural productivity.

Two small pockets of very low productivity lie in Bhojpur district. One of them consists of Shahpur, Brahampur and Simiri anchals and is located in the extreme north-eastern corner surrounded by the low poductivity region. In these anchals kharif crops are not cultivated due to logging of flood water from the river Karamnasa during the rainy season. The yield of crops is low specially due to excess of waterlogging, siltation of sand

and development of wide and deep polygonal cracks in old alluvium soil. Apart from that, the level of technological advancement is also low.

The next small pocket of Rajpur and Dinara anchals lies in the west-central part of Bhojpur district. The causes for very low productivity are more or less same as in the case of above but efficiency and frequency of all these factors have decreased more in this region. However, the most significant and influencing factor in this pocket is the scarcity and variability of rainfall.

Rajgir anchal in Nalanda district and Mohanpur anchal in Gaya district are two important hilly anchals with very low agricultural productivity forming islands among the high and medium productivity regions. Although there are numerous causes for their very low productivity, the important among them are the rough and hilly terrain as well as insufficient moisture present in the soil. These two environmental constraints have hindered the agricultural productivity. The low incentive to farmer to increase productivity is also one of the factors for very low productivity.

Extremely Low Productivity Region:

The anchals which have recorded productivity coefficient less than 30 per cent of regional average have been categorised under this group. Altogether seven anchals (about 4.8 per cent of the total anchal) lie in it. They are scattered in two different pockets. Five anchals are concentrated along the wide range of Kharagpur hills in Munger district and another two anchals are lying in Nawada district near the Chota Nagpur plateau.

The first pocket of five anchals is an inescapable land-scape of quartzite triangular plateau of Kharagpur hills in the district of Munger. It is composed of metamorphosed Dharwar-sedimentaries rocks like quartzites, schists, slates. It is affected by rough and hilly terrain as well as insufficient moisture contained in the soil which primarily affects the yield of agricultural crops. The region benefits from the north-western showers in the hot weather season. The soil is mostly older alluvium which is composed of a rather pale reddish brown hue with Kankar and pisolitic ferruginous concretions (Gazetteer Bhagalpur, 1962). The erratic nature of rainfall and hilly terrain soil affect the yield of agricultural crops. Moreover, this area is also ineffective and there is lower level of mechanisation. Due to poor soil it is a monoculture area. In extreme north, Munger anchal is frequently affected by floods during the rainy season. Maize is an important crop of this area. The similar codition has developed in Gobindpur and Kauakol anchal of Nawada district. It is also hilly and dissected terrain of Chota Nagpur plateau. Physically, these anchals are not suited for agricultural crops.

Conclusion:

This paper has examined the regional variations in land productivity in South Bihar Plain. The analysis indicates that the productivity is average. There is a substantial scope for incseasing agricultural production in some regions of South Bihar Plain.

Figure 1 shows that high productivity is spatially distributed in four different pockets in thity-one anchals of Bhojpur, Rohtas, Gaya, Patna, Nalanda and Bhagalpur districts, while the moderate productivity is scattered all over the region. The low productivity is concentrated in those areas where physical and technological constraints are more. They are located in either northern flood plain,

southern and eastern hilly area or the western dryland area. Each region has its own significance.

Although in terms of per unit area, the agricultural productivity in the region is low in relation to the state and country average and has remained so for many decades for several reasons. Perhaps, the most significant devtlopment in productivity in the region occured in recent years through a shift from traditional agriculture to modern agriculture. Modern agriculture ushered in an area of change in techniques and production inputs that were unknown only a few decades ago. This change increased considerably the yield per hectare of several crops and thereby average agricultural productivity. However, the average yields of several crops are still below national average and far behind the developed regions, i.e., Punjab, Haryana and Uttar Pradesh. The unimpressive change in average productivity in the region is due to unequal diffusion of agricultural innovations from one area to another. In some areas where the new agriculture has taken firm hold, in association with good irrigation, a high level of purchased inputs, relatively larger holdings and medium density of population, productivity has recorded remarkable increase. In some cases the physical environment is good but the man-made environment is more favourable. The regression results at micro-level (selected village) provides good support to the above conclusion. Fertilizer is positively correlated with agricultural productivity, the coefficient being r =.669 or 44 per cent. Similarly, it has an average relation with literacy as well as percentage of irrigated land to the total cropped land. It provides greater objectivity and portrays a more realistic regional pattern of agricultural productivity.

Similarly, low productivity occurs under different situations. In hilly areas, western dry and northern waterlogging area, it is mainly due to physical constraints of terrain or insufficient moisture as well as excess of flood water. Along the river side and central areas, it appears to be more due to socio-economic constraints. High pressure on the land has led to very small holdings and high inputs of labour without similar increase in the level of purchased inputs. Due to lack of capital investment farmers are unable to use yield augumenting inputs in adequate quantities. They have also low risk-bearing capality because their output is geared mainly to subsistence. Hence, they use labour intensive techniques to produce enough low value foodgrains.

To increase agricultural productivity over large areas in the South Bihar Plain a number of actions are required. Firstly, there is an urgent need for expanding irrigation resources and fertilizer supply and improving capital or credit facilities (rural bank) in order to allow small farmers to benefit from the availability of physical inputs. Further, expansion of irrigation facilities in the areas is required where they are at present inadequate. Even small ponds in the fields or unused barren land to hold rain water for irrigation may considerably increase productivity. The loss of some cultivated area (from flood water) may be compensated for by substatial increases in output. Secondly, there is a desperate need for a transfer of population from agriculture to non-agricultural activities. This may lead to larger holdings and reduce the rate at which diminishing returns appear to be setting in. Thirdly, the significance of urban-industrial development in this analysis suggests that a decentralized policy of urban industrial development will benefit agriculture. It

may also help transfer of population from agriculture to non-agricultural activities. Fourthly, agriculture wages in rural areas are appallingly low and have not increased in the same proportion as the cost of living. The profitability of agriculture has greatly improved, but profits have not been passed on to the workers.

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