CHAPTER 4

PATTERN OF AGRICULTURAL PRODUCTIVITY

Agricultural productivity is one of the components of regional development. It is a multidimensional concept which includes number of complex factors viz. environmental, technological and institutional. These factors affect the agricultural development of a region.

It may be pointed out that the agricultural development should be assessed by the agricultural production and productivity, and also by various physical inputs, extent of cultivated area, irrigation, fertilizers, improved seeds and labour availability. If assessed in this manner, agricultural development may constitute as one of the significant components of regional development. It provides increased food surplus to growing population, helps to expand the secondary and tertiary sectors, increases rural incomes and improves the welfare of the population of the region.

The concept of integrated agricultural development means viewing agriculture not as a separate sector but rather as a branch of economy completely integrated into the development process and contributing to the fulfillment of the objectives which society as a whole has set for itself. It may be noted that agricultural surplus increases the rural incomes which tend to improve the quality of life of rural people. This surplus gives the chance to the villager to consume more nutritive food in the form of superior quality cereals, eggs, ghee...
(refined butter), milk, fruits etc. They build better houses get vehicles and also receive the facilities such as irrigation, banking, transport, schools, health centres etc. Thus increased agricultural surplus plays a vital role in raising the standard of living of the overwhelming majority of the rural population of an area. In this context it is felt that the approaches which are preferable in the fields of agricultural productivity should be appropriately selected in the present study appropriately. The selected approaches should be sensitive enough to explain quite a sizeable proportion of the total variation in the agricultural productivity.

The regional variations in the pattern of agricultural productivity of Bihar have been assessed by applying two methods for measurement of agricultural productivity. A district has been selected as unit of the study. All the important crops grown in the region have been considered for the computation of the productivity for the year, 1980-81 and 1990-91.

The following methods have been adopted for measuring the agricultural productivity for the area under study.

1. Agricultural Productivity: Based on Yang's Crop Yield Index

Yang's Crop Yield Index method considers yield of different crops selected in a district compared with the average crop yield in the entire region. The procedure for calculating the crop yield index for a district X is explained here. In the beginning, the average yield of each of the crops grown in the entire region is determined. Later on a
value is obtained by dividing the yield per hectare of a crop in district X by multiplying with 100 gives the index number as shown in col. 5 of Table 2. By considering the area devoted to each crop as a weight and multiplying it with the percentage index, the products are obtained as listed in column 6 of Table 2. By adding the products of different crops and dividing the sum of products by the total area in the district X (the sum of col. 4), the average index obtained is the desired crop index for a particular unit using crop area as a weight.

Table 2

Method of Calculating Crop Yield Index² of the District X

<table>
<thead>
<tr>
<th>Crops</th>
<th>Yield in Quintal per hectare</th>
<th>Area Under crop in the district X</th>
<th>Crop Yield in the district X as a % of entire region under crop (col.3/col.4x100)(col.5xcol.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>12.90</td>
<td>12.00</td>
<td>91648</td>
</tr>
<tr>
<td></td>
<td>93.02</td>
<td>8525096.6</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>12.80</td>
<td>11.30</td>
<td>89573</td>
</tr>
<tr>
<td></td>
<td>88.28</td>
<td>7907504.4</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>6.50</td>
<td>11.80</td>
<td>45589</td>
</tr>
<tr>
<td></td>
<td>181.54</td>
<td>8276227.0</td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>7.60</td>
<td>6.60</td>
<td>3456</td>
</tr>
<tr>
<td></td>
<td>86.84</td>
<td>300119.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>230266</td>
<td>25008947.0</td>
</tr>
</tbody>
</table>

Crop index for the district X = \[
\frac{25008947.0}{230266} = 108 \text{ percent}
\]
2. Agricultural Productivity: Based on Agricultural Output per Hectare of Cropland (Price Weighted)

This method of productivity measurement has certain advantages, because land is the most permanent and fixed among the other factors for evaluating productivity. Recently it has assumed a special attention due to population explosions and relative return from it. In order to evaluate productivity indices in each district farm level harvest prices for the corresponding years have been incorporated. This gives the agricultural output per hectare (in Rs.). These indices of a farm output have been computed by multiplying the harvest price to the production of the crop concerned. These products were finally added up and divided by the total crop area to get the value of output per hectare (in Rs.).

Agricultural Productivity Regions

A uniform technique of standard deviation (SD) is used in delineating the agricultural productivity regions. The computed values of productivity indices are given in Appendix B. On the basis of these productivity indices mean and standard deviation have been calculated for both the index as given in Table 3.
Table 3

Parameter of Agricultural Productivity Indices

<table>
<thead>
<tr>
<th></th>
<th>1980-81</th>
<th>1990-91</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X_1)</td>
<td>88.74</td>
<td>92.01</td>
</tr>
<tr>
<td>(X_2)</td>
<td>2040.21</td>
<td>5280.56</td>
</tr>
<tr>
<td>Mean</td>
<td>19.91</td>
<td>23.42</td>
</tr>
<tr>
<td>S.D.</td>
<td>17.92</td>
<td>16.72</td>
</tr>
<tr>
<td>C.V.</td>
<td>17.92</td>
<td>25.45</td>
</tr>
</tbody>
</table>

\(X_1\) = Yang's Crop Yield Index

\(X_2\) = Agricultural Output per Hectare (in Rs.)

S.D. = Standard Deviation

C.V. = Coefficient of Variation

Agricultural productivity regions are demarcated by plotting productivity indices of the districts in the map. Areas of high, medium and low productivity regions are demarcated with the help of a graded scale prepared by arranging all the indices of two points of time in a descending order and selecting five sets of very high, high, medium, low and very low values. The productivity regions thus obtained are shown with the help of maps.

Productivity Regions: Based on Yang's Crop Yield Index Method 1980-81

In the year 1980-81 Yang's Crop Yield Index varies in the region from 116.27 (Nalanda) to 54.96 (Palamu) (Appendix B). This variation
is further confirmed by a coefficient which is variation of 17.92%.

In the regional pattern two distinct small areas of very high agricultural productivity are found as shown in Fig. 7, one lies in the north-western part of the state and includes the districts of Champaran East (113.93), Champaran West (115.80) and Sitamarhi (104.27), the other which is consists of Nalanda (116.27), Patna (107.69) and Begusarai (106.77) form a compact block in the Central part of the state. There are three small areas of high productivity regions, ones lies in the northern part of the state including the districts of Vaishali (90.58) and Samastipur (100.83), the second lies in the north eastern part and includes the districts of Purnia (97.58) and Bhagalpur (96.50) and the third lies in the south-eastern part of the state which includes the districts of Giridih (100.57) and Dhanbad (90.63). Apart from this there are three scattered districts, which fall under the category of high agricultural productivity which are Siwan (94.95), Rohtas (90.13) and Ranchi (94.63). The area under very high and high productivity regions cover the 49 percent of the net sown area. Out of which only 16 percent area comes under very high agricultural productivity.

The areas of medium agricultural productivity grade form two contiguous regions in the north-western part of the state. It includes the districts of Bhojpur (80.50), Saran (87.42), Gopalganj (89.17), Muzaffarpur (85.07) and Darbhanga (88.17). Another contiguous region of medium productivity lies in the south-eastern part and it includes the districts of Hazaribagh (78.12), Nawada (84.62), Munger (78.50), Santhal Pargana (84.77) and Katihar (81.27). The area under medium
BIHAR
PRODUCTIVITY REGIONS:
BASED ON YANG’S YIELD INDEX METHOD
1980-81

PRODUCTIVITY INDEX
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW

FIG. 7
agricultural productivity covers a net sown area of 2527 thousand hectares which is 30 percent of the net sown area.

Out of four districts having low agricultural productivity, two districts form a small block in the south-central part of the state. It includes the districts of Aurangabad (76.00) and Gaya (77.43). Other two districts are scattered over other parts of the state are Saharsa (71.01) and Singhbhum (66.05). There are only two districts of very low agricultural productivity. They are Palamu (54.96) in the south-west and Madhubani (55.54) in the north. The low and very low agricultural productivity regions cover a net sown area of 1790 thousand hectares which is 21 percent of the net sown area. Productivity regions based on Yang's Yield Index has been shown in Fig.7.

Table 4

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Above 102</td>
<td>16</td>
<td>18</td>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>90-102</td>
<td>33</td>
<td>24</td>
<td>9</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>78-90</td>
<td>30</td>
<td>25</td>
<td>10</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>66-78</td>
<td>16</td>
<td>20</td>
<td>4</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V. Low</td>
<td>Below 66</td>
<td>5</td>
<td>13</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
<td>100</td>
<td>31</td>
<td>42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Based on Yang's formula)
Productivity Regions: Based on Yang's Crop Yield Index Method 1990-91

Yang's Crop Yield Index varies in the region from 135.27 (Nalanda) to 51.87 (Singhbhum East). Appendix C. This variation is also confirmed by the coefficient of variation, which is 25.45%. In the year 1980-81 it was only 17.92%.

The regional pattern shows that two small blocks of very high productivity regions are identified which is depicted in Fig.8; one lies in the central-eastern part and includes the districts of Rohtas (126.41) and Bhojpur (127.83); the other lies in the central part of the state which includes the districts of Nawada (130.49) and Nalanda (135.27). Champaran East (117.79) is the only other district which comes under this category of very high agricultural productivity, but do not form any region. As far as high agricultural productivity regions are concerned there are eleven districts which comes under this category. They form a large contiguous region which includes the districts of Champaran West (100.17), Gopalganj (112.98), Siwan (106.09), Saran (108.98), Patna (122.37), Vaishali (106.90), Samastipur (111.75), Begusarai (106.65), Khagaria (103.19), Jehanabad (111.25) and Gaya (101.90). The very high and high agricultural productivity regions covers net sown area of 315 thousand hectares which is 42 percent of net sown area, out of which 18 percent area is under very high agricultural productivity.
BIHAR
PRODUCTIVITY REGIONS:
BASED ON YANG'S YIELD INDEX METHOD
1990-91

FIG. 1
The majority of the districts come under medium agricultural productivity. There are twelve districts which come under medium grade of agricultural productivity. They form two contiguous regions, one in the northern part of the state which includes the districts of Sitamarhi (96.77), Muzaffarpur (96.34), Madhubani (98.53) and Darbhanga (93.53). The other lies in the central-eastern part of the state and includes the districts of Munger (86.92), Deoghar (98.38), Dumka (94.15), Sahibganj (85.02) and Katihar (90.46). There is a small block of medium agricultural productivity in northern part of the state and includes the districts of Madhepura (96.89) and Araria (86.33). The district of Aurangabad (84.96) also comes under this category of medium agricultural productivity. These medium agricultural productivity areas cover net sown area of 1884 thousand hectares which is 25 percent of area of the state.

The low agricultural productivity region form a contiguous belt from northern-eastern to south-eastern part of the state and includes the districts of Dhanbad (69.01), Girdih (74.61), Lohardaga (77.42), Ranchi (78.58), Godda (79.44) Saharsa (79.78), Bhagalpur (81.47), Kishanganj (82.69), Purnia (82.92) and Singhbhum West (82.87). It covers the net sown area of over 1542 thousand hectares which is 20 percent of the net sown area. The very low agricultural productivity areas are found in southern part of the Bihar as shown in Fig.9. The districts under very low agricultural productivity are Palamu (56.43), Gumla (61.94), Hazaribagh (67.10) and Singhbhum East (51.87). They cover the area of about 877 thousand hectares which is 13 percent of net sown area.
Productivity Regions: Based on Agricultural Output per Hectare (in Rs.) 1980-81

Regional pattern of agricultural productivity on the basis of output per hectare shows a wide range of variation. It varies from a minimum of Rs. 1253 in Palamu to the maximum of Rs. 2696 in Sitamarhi (Appendix B). This variation is further confirmed by the coefficient of variation which is 17 percent.

Regional pattern shows that a distinct and compact region of very high productivity grade is found in the central part of the state as shown in Fig.9. It comprises the districts of Patna (2417.47), Begusarai (2434.76), samastipur (2499.76) and Nalanda (2613.20). The districts of Champaran west (2603.28) and Sitamarhi (2696.04) are also have very high agricultural productivity but they are scattered apart and do not form any identifiable region. The districts of high agricultural productivity are also scattered apart from each other and therefore, they fail to constitute any identifiable region. The districts having high agricultural productivity are also scattered apart from each other and therefore, they fail to constitute any identifiable region. The districts having high agricultural productivity are Siwan (2128.24), Bhagalpur (2152.60), Giridih (2234.65), Purnia (2238.79), Rohtas (2369.72) and Champaran East (2400.61). The very high and high agricultural productivity region cover an area of 3012 thousand hectare which is 37 percent of the net sown area in the year 1980-81, out of which very high agricultural productivity share is 13 percent.

The regional pattern of the distribution of medium agricultural productivity shows that the major areas of medium agricultural
BIHAR
PRODUCTIVITY REGIONS:
BASED ON AGRICULTURAL OUTPUT PER HECTARE (in Rs.)
1980-81

RS / HECTARE
VERY HIGH 2408
HIGH 2120
MEDIUM 1832
LOW 1544
VERY LOW

FIG. 9
productivity are mainly concentrated in north-western part and south-central part of the state and form two contiguous regions. The districts of contiguous regions are Gopalganj (1931.69), Saran (1944.32), Bhojpur (1997.24), Vaishali (1991.11), Muzaffarpur (1903.97) and Darbhanga (1880.09). Whereas, the districts of the south-central contiguous region are Nawada (2010.42), Hazaribagh (1847.95), and Ranchi (2025.81). Santhal Pargana (1791.87) also fall in this category of medium agricultural productivity. Medium agricultural productivity region cover area of 2841 thousand hectares which is 34 percent of net sown area of the state.

The study of Fig. 9 reveals that there is a large region of low agricultural productivity in the central-northern part of the state. It includes the districts of Aurangabad, Gaya, Nawada, Munger, Saharsa and Madhubani. The districts of Katihar Dhanbad and Singhbhum also have low agricultural productivity. It is interesting to note that in 1980-81, Palamu is the only district in the category of very low agricultural productivity. The low and very low agricultural productivity region cover an area of 2412 hectares which is 29 percent of the net sown area of the state.

**Productivity Regions: Based on Agricultural Output per Hectare (in Rs.) 1990-91**

Regional pattern of agricultural productivity on the basis of output per hectare shows a wide variation in Bihar. It varies from a minimum of Rs. 3119 in Singhbhum East to the maximum of Rs. 6934
BIHAR

PRODUCTIVITY REGIONS:
BASED ON AGRICULTURAL OUTPUT PER HECTARE (in Rs.)
1990-91

FIG. 10
in Champaran East (Appendix C). This variation is also confirmed by the coefficient of variation which is 17 percent.

### Table 5

**Bihar: Price Weighted per Hectare Productivity**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Index</th>
<th>Net sown area as% of Gross Cropped area</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. High</td>
<td>Above 2408</td>
<td>Above 6171</td>
</tr>
<tr>
<td>High</td>
<td>2120-2408</td>
<td>5408-6171</td>
</tr>
<tr>
<td>Medium</td>
<td>1832-2120</td>
<td>4645-5408</td>
</tr>
<tr>
<td>Low</td>
<td>1544-1832</td>
<td>3882-4645</td>
</tr>
<tr>
<td>V. low</td>
<td>Below 1544</td>
<td>Below 3882</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The regional pattern of agricultural productivity as shown in Fig. 10 reveals that there are two small blocks of very high agricultural productivity region in the central and north-western part of the state. It includes the districts of Samastipur (6616.93), Begusarai (6422.01), Khagaria (6329.83), Siwan (6286.34), Saran (6614.14) and Champaran East (6934.79). A contiguous belt of high agricultural productivity is found in the central-northern and central-western part of the state. This comprises the districts of Madhubani (5619.01), Darbhanga (5658.11), Muzaffarpur (5577.41), Vaishali (5691.41) Patna (5689.85), Bhojpur (5742.05), Rohtas (5791.10), Nalanda (6156.15) and Nawada (5892.50). Apart from this there are two small blocks of high agricultural productivity regions, one lies in the north-western part of
the state and includes the districts of Champaran West (6095.20) and Gopalganj (6043.17), the other lies in the south eastern part and includes the districts of Deoghar (5892.08) and Dumka (5472.20), the districts of Katihar (5603.86) and Madhepura (5663.91) also have high agricultural productivity, but they do not form any region. The area under very high and high agricultural productivity region is 3955 thousand hectares which is 52 percent of net sown area, out of which very high agricultural productivity contributes only 14 percent.

The major concentration of medium agricultural productivity is found in central, north-eastern and eastern part of the state and it includes the districts of Sitamarhi (5399.37), Saharsa (4750.83), Araria (5154.05), Kishanganj (4922.23), Purnia (4975.79), Bhagalpur (4947), Munger (5376.53), Sahibganj (4992.57), Jehanabad (4968.70), Aurangabad (5132.40), Gaya (4874.33) and Ranchi (4929.32). There are twelve districts in the medium agricultural productivity grade. They covers an area of about 2318 thousand hectares which is 30 percent of net sown area.

The low and very low productivity grade are mainly confined to southern part of the state. The districts under low agricultural productivity are Godda (4539.24), Giridih (4587.44), Hazaribagh (4137.02) and Lohardaga (4520.59). The districts under very low agricultural productivity grade are Palamu (3394.79), Gumla (3730.02), Singhbhum West (3241.73) and Singhbhum East (3119.45). The area under low and very low productivity region is 1359 thousand hectares which is 18 percent of net sown area.
Factors of Spatial Variations in Agricultural Productivity

The above analysis reveals that the levels of agricultural productivity generally decreases from north to south. There are many factors at work which cause this spatial pattern of agricultural productivity in the state. Among natural factors, relief, rainfall and soils may be significant to explain some of the variance in the agricultural productivity. The distribution of rainfall as given in Table 1 indicates that more or less there is an even distribution of rainfall in the state, but topography of south Bihar plateau is such that it allows the quick run off of the rainwater and it is not generally available for irrigation after rainy season. But in north plain it is used for irrigation when the rainy season is over. Some of the agricultural productivity indices shows a regional pattern which is significantly related with the pattern of rainfall and topography. As far as soil factor is concerned, sandy and less fertile soils are concentrated mainly in the southern part of the state (Fig. 6) where agricultural productivity is generally low to very low. With few exceptions, it is interesting to note that all the indices invariably show high and very high level of agricultural productivity in the Bihar plain where soils are very fertile that have been derived from the alluvium deposited by Ganga and its tributaries. These fertile soils are highly suited for the cultivation of wheat, rice, sugar can and maize etc. Per hectare yield as well as money value of crop is high which contributes to the high level of productivity in this
Among the technological variables irrigation, high yielding varieties of seeds (HYVs), use of fertilizers and agricultural practice of multiple cropping (agricultural intensity) are found as significant correlates of agricultural productivity.

The spatial distribution of area under irrigation in 1980-81 and 1990-91 has been shown in Fig.11 and Fig.12 respectively. Very high and medium grade of percent area is mainly concentrated in central-western and north-western part of the state and it declines towards southern and eastern part of the state. The topography of southern Bihar is rugged and undulating and is not suitable for the construction of canals and tube-wells, the agriculture in this region is mainly dependent on the vagaries of monsoon. The general pattern of irrigation has a marked positive association with the pattern of the levels of agricultural productivity.

High yielding varieties of seeds are generally less resistant to droughts, floods and various diseases and need an efficient management of water and chemical fertilizers. Any lapse on the part of cultivator in application of inputs may substantially reduce the production and productivity. High yielding varieties of seeds are used on small scale due to lack of assured irrigation, capital and chemical fertilizers etc. High yielding varieties of seeds show a close conformity with the spatial pattern of agricultural productivity. The distribution of high yielding varieties of seeds have been depicted in Fig.13 and Fig.14.
BIHAR
AREA UNDER HIGH YIELDING VARIETIES
1980-81

PER CENT AREA

VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW

FIG. 13
BIHAR
AREA UNDER HIGH YIELDING VARIETIES
1990-91

FIG. 14
BIHAR
CONSUMPTION OF FERTILIZERS
1990-91

FIG. 16
for the year 1980-81 and 1990-91 respectively. These figures show that very high concentration area under high yielding varieties of seeds is in the central-western part of the state where agricultural productivity has been also recorded very high, while in southern and south-eastern parts of the state the use of HYV of seeds is low resulting into low productivity. The distribution of fertilizers consumption has been shown in Fig.15 and Fig.16. An analysis of these figures reveals that pattern of distribution of chemical fertilizers consumption in the state is similar to that of high yielding varieties of seeds and it is strongly associated with the levels of agricultural productivity.

With minor variations agricultural intensity i.e. proportion of area sown more than once is in close proximity with general pattern of agricultural productivity as shown in Fig.17 and Fig.18. The high and very high levels of agricultural intensity regions are closely associated with the regions of very high and high agricultural productivity. The medium, low and very low agricultural productivity is found in the medium, low and very low levels of agricultural intensity regions.

This examination of possible factors of spatial variation in the levels of agricultural productivity suggests that technological factors are comparatively more strongly associated with the levels of agricultural productivity than the natural factors which have a relatively weak relationship with the levels of agricultural productivity.
BIHAR
AGRICULTURAL INTENSITY
1980-81

PERCENT AREA SOWN
MORE THAN ONCE

VERY HIGH 53
HIGH 41
MEDIUM 29
LOW 17
VERY LOW

FIG. 17
REFERENCES

1. Cereals - Rice, wheat, Barley, Maize.
Cash Crops - Sugarcane, Potato, Jute.
Pulses - Gram, Masoor, Arhar, Khesari, Pea.
Oil seeds - Linseed, Rape seed and Mustard.

