Chapter- VI

6.0 LEVEL OF AGRICULTURAL PRODUCTIVITY

6.1 Introduction

The term productivity used in various ways and it has generated many conflicting interpretations. Some scholars have defined productivity as ratio of output to resources allocated. Others have opined that productivity is the overall effectiveness of a productive unit while another group has considered the term productivity as to define the ratio of output to the corresponding input of labour. Agricultural productivity is the ratio of output to input in relation to land, labour and output and in terms of the overall resources employed in agriculture sector (Mohammed & Thakur, 1980).

Due to its multifarious utility, scholars from different disciplines, especially in the field of agricultural geography and agricultural economics have long been engaged to measure the agricultural productivity (crop productivity), agricultural efficiency (crop efficiency) in various parts of the world. Thompson (1926) while computing the relative productivity of agriculture in Britain and Denmark stressed and expressed it in terms of gross output of crops and livestock. He identified seven parameters that involved in assessing agricultural productivity. Buck (1937) while measuring the agricultural productivity adopted the technique of *grain equivalent*. He converted all the agricultural products into kilograms of grain equivalent for the selection of unit measurement in kilograms of predominant grain in the region.

B.N. Ganguly (1938) developed indices of the contribution of nine leading crops to measure the agricultural efficiency of Ganges valley. Index of agricultural efficiency by Ganguly is as follows:

$I_{ij} = (Y_{ij}/Y_i)$ 6.1

$E_{ij} = \sum (I_{ij}.C_j) /100$ 6.2

$E_i = E_{i1}+E_{i2}+ \ldots\ldots E_i n /N$ 6.3

Where: I_{ij} is the % yield of crop j in i^{th} areal unit, Y_{ij} is the yield of jth crop in i^{th} areal unit; Y_{rj} is the yield of jth crop in i^{th} region, E_{ij} is the efficiency of jth crop in the ith areal unit; C_j is the % of land share of jth crop and E_i is agricultural efficiency of ith areal unit.

The need to determine statistically the spatial variations in crop productivity was first realize by M.G. Kendall (1939) who devised the *ranking coefficient technique* for this purpose, which is as follows:

$$A_e = r^1 + r^2 + \ldots\ldots r^n / n \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 6.4$$

Where: A_e is ranking coefficient; r is rank of component areal unit according to yield rate and n is number of crops.

H.G. Hirsch (1943) emphasized *crop yield index* as the basis of productivity measurement. Crop yield index indicates the yields of various crops on a farm or in a locality relative to the yields of the same crops on another farm in the other locality. S.P. Zobel (1950) attempted to assess the labor productivity. He expressed productivity of labor as the ratio of total output to the total man-hour. L.D. Stamp (1952) used Kendall's ranking co-efficient technique in order to determine agricultural efficiency of various countries for major crops only. In 1958, L.D. Stamp designed another method for computation of the agricultural productivity by converting the total agricultural production in calories that popularly known as standard nutrition unit for international comparison by selecting 20 countries and 9 crops. M. Shafi (1960) also used the technique of Kendall's ranking co-efficient for determining the farm efficiency of Uttar Pradesh by considering the yield of eight food grain crops. However, it was criticised, as it did not incorporate the areal strength of crops.

De Veries (1957) used the output in selected Asian countries in terms of *husked-rice-equivalent* per head of population as a device to measure agricultural progress after converting various grains into rice-equivalent according to their local market price. S.G. Sapre and V. D. Deshpande (1964) modified the ranking co-efficient of Kendall and used the weighted ranking co-efficient technique instead of simple averaged ranks. The weights of ranks of various crops are being proportional to the percentage of cropland under respective crops. However, they considered net area sown instead of the net area harvested.

Gyorgy Enyedi (1964) while analyzing the agricultural types in Hungary develops a model for assessing agricultural productivity. He used the following productivity co-efficient:

$$Y / Y_n : T / T_n \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 6.5$$

Where: Y is total yield of the respective crop in the unit area, Y_n is total yield of the crop at national level, T is total cropped area of the unit, T_n is total cropped at the national level.

S. P. Dhondyal (1964) has also assessed variations in agricultural development and productivity by selecting three representative districts from the three regions of Uttar Pradesh for 1962-63. J.S. Garg (1964) computed the trends in agricultural development related with total cropped area, gross irrigated area, and food grain production in the two districts of Uttar Pradesh. J.S. Sharma (1965) assessed productivity in relation to land, labour and capital. A.M. Khusro (1965) preferred to use 'paid out costs' in relation to 'output', i.e., assessment of productivity with the output per unit of a single input and output per unit of cost of all inputs in the agricultural production. While, R. Saran (1965) used Cobb-Douglas production function approach for the measurement of productivity. This function is commonly used to express the input/output relationship between various inputs and one output in the agricultural systems. The equation of the function is as follows:

$$Y = A\, x_1^{b}\, x_2^{c}\, x_3^{d}\, x_4^{e} \;\ldots\ldots\; x_n^{y}. \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 6.6$$

Where, x_1, x_2, x_3, x_4 ..... x_n refer several inputs such as land, labor, capital assets and other expenditures related with agricultural activities. The values of b, c, d, ... y denotes elasticity of the respective inputs.

S.B. Tambad (1965 and 1970) assessed the agricultural productivity by applying the Crop Yield Index. He opined that the objective of this technique to represent the average yield of various crops on a farm or in a region relative to the yield of same crops on an another farm or in a second region. M. Shafi (1972) assessed the productivity based on model developed by G. Enyedi (1964) after introducing necessary modification. The model thus developed:

$$(y_w/t+y_r/t+y_m i/t \;\ldots\ldots\ldots n):(Y_w/T+Y_r/T+Y_m i/T\ldots\ldots\ldots n) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \; 6.7$$

Where: y_w, y_r, $y_m i$ is total yield of a particular crop in the district; Y_w, Y_r, $Y_m i$ is total yield of a particular crop at the national level; t is net area under the crop in the district and T is net area under the crop at the national level.

R.R. Agarwal (1965) has suggested *factorial approach* while measuring agricultural efficiency in Bastar district of Madhya Pradesh. He considered a number of human controlled factors relating to agricultural production have been selected, excluding the environmental factors. S.S. Bhatia (1967) while assessing the changes & trends in agricultural efficiency in Uttar Pradesh during 1953-1963 adopted B.N.Ganguli's (Eq. 6.1, 6.2 & 6.3) method and developed a modified model as follows:

$I = (y^c/y_r) \times 100$ 6.8

Where, I_{ya} is the yield index of crop a; Y^c is the average acre yield of yield of crop a in the component unit and Y_r is the average acre yield of crop a in the area.

$E_i = I_{ya}.C_a + I_{yb}.c_b + \ldots\ldots\ldots I_{yn}.C_n / C_a + C_b + \ldots\ldots\ldots C_n$ 6.9

Where, E_i is the agricultural efficiency index; I_{ya} I_{yb} is the indices of various crops and C_a C_b is the proportion of cropland devoted to different crops.

S.S. Bhatia assumed that per acre yield expresses all the physical and human factors concerned with the production of crops and the sharing of crops reflects various factors involved in land utilization. The agricultural efficiency would be aggregate performance of various crops in regards to their output per acre but the contribution of each crop to agricultural efficiency would be relative to its share of the cropland. Bhatia's method seems to be of some use to show the *agricultural efficiency* but it fails to pin point the position of efficiency in relation to regional context while individual efficiency of each district is being determined. M. Shafi (1967 & 1969) applied Stamp's *standard nutrition unit* technique for measuring the efficiency of agriculture in India. He has considered the district as the areal unit and has selected all the food crops grown in India. N. Muhammad (1967) considered *net total productivity* as a method for the measurement of productivity and comparison in time or in space. The purpose of the measure is to account changes in labor and capital inputs in agriculture.

B.N. Sinha (1968) has adopted a standard deviation formula to determine agricultural efficiency in India. He selected 25 major crops grown in the country which were grouped into cereals, pulses, oilseeds and cash crops and specific yields per hectare of cereals, pulses and oilseeds where taken. Moreover, in case of money crops, their monetary value calculated in rupees per hectare by incorporating wholesale market prices. J. Singh (1972) has formulated another technique for the measurement of agricultural efficiency. This technique expresses the measurement of population carrying capacity per unit area in respect of output per unit area. The model thus developed:

$C_p = C_o/S_n$ 6.10

$I_a e = (C_p e/C_p r) \times 100$ 6.11

Where, C_p is carrying capacity; C_o is caloric output; S_n is standard nutrition for ingestion in calories per person/annum; $I_a e$ is index number of agricultural efficiency; $C_p e$ is population carrying capacity in the areal unit and $C_p r$ is population carrying capacity in the entire region.

6.2 Measurement of Agricultural Productivity

The measurement of agricultural productivity and the identification of production patterns have long been an important field of study of agricultural geographers. The term productivity has been widely used in the literature to examine the spatio-temporal pattern of agriculture. Although agricultural productivity differs from one region to another region, and the factors for such variations are many, the determination of variations in agricultural productivity and their possible reasons help to demarcate the regions of agricultural productivity. Therefore, in order to indicate the accurate level of integrated agricultural performance in spatio-temporal dimensions and for appropriate planning for the development of every region with its physico- socio-economic conditions, measurement of agricultural productivity is necessary. In order to determine the level of agricultural productivity and agricultural efficiency in Koch Bihar district and the spatial variations at block level the following models have attempted:

i) Crop yield and concentration indices of ranking co-efficient method J. Singh (1972);
ii) the model developed by S.S. Bhatia (1967) and
iii) the P/A ratio developed by B.N. Sinha (1968).

An attempt is been made to study block level variation in agricultural productivity and agricultural efficiency in Koch Bihar district at a given point of time and temporal variation in agricultural productivity and agricultural efficiency between two points of time namely, 1980-81 and 2004-05.

6.2.1 Crop yield and concentration indices (CYCI)

For an objective measurement of the level of agricultural productivity, the relative crop yield and concentration indices arranged in to ranking order and computed into average ranking co-efficient would give a measure which may be called the Crop Yield and Concentration Indices Ranking Co-efficient. The methodology as developed by Singh (1972) as follows:

$$Y_i = (Y_{ac}/Y_{ar})*100 \qquad \text{.....} \quad 6.12$$

Where, Y_i is the crop yield index; Y_{ac} is the average yield per hectare of crop a in the component enumeration unit and Y_{ar} is the average yield per hectare of crop a in the district.

$$C_i = (P_{ac}/P_{ar})*100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 6.13$$

Where, C_i is the crop concentration index; P_{ac} is the percentage share of the crop a in the gross cropped area in the block and P_{ar} is the percentage share of the crop a in the gross cropped area in the district.

The crop yield and concentration indices (CYCI), thus, derived for blocks and for the crops ranked separately. Yield and concentration ranks for individual crops averaged to determine CYCI. This offers a clear idea about the level of agricultural productivity i.e., lower the ranking co-efficient, higher the level of agricultural productivity and vice-versa. Ranking co-efficient for individual crops are arranged in ascending order and tabulated in table 6.1, 6.2 and 6.3 and represented in figures 6.1a, 6.1b, 6.1c, 6.1d, 6.2a, 6.2b, 6.2c and 6.2d. This indicates the regional imbalances in levels of productivity that may be related with salient characteristics of physical and socio-economic determinants.

The crop yield and concentration indices (CYCI) ranking co-efficient of nine crops in Koch Bihar district reveals that the regional differences are more common in the level of productivity of various crops in the district. In order to identify the variation in efficiency at block level for different crops, individual crop ranking coefficients discussed in the following sections:

Table 6.1 Crop yield and yield concentration indices ranking co-efficient (2004-2005)

Rank	Paddy		Wheat		Jute	
	Indices	Block	Indices	Block	Indices	Block
1	91.3	Mathabhanga II	54.5	Haldibari	61.1	Tufanganj II
2	109.9	Haldibari	60.6	Sitalkuchi	81.5	Sitai
3	110.2	Dinhata I	74	Dinhata II	88.9	Tufanganj I
4	110.9	Kochbehar I	89.2	Sitai	90.7	Mathabhanga I
5	111.9	Mekhliganj	89.4	Mathabhanga I	93.1	Mekhliganj
6	115.1	Koch Behar II	89.4	Dinhata I	99.5	Dinhata II
7	117.7	Sitai	95.9	Tufanganj II	100.6	Koch Behar II
8	120.9	Sitalkuchi	102.5	Mathabhanga II	102.7	Dinhata I
9	121.3	Dinhata II	104.5	Koch Behar I	106.2	Sitalkuchi
10	124.4	Mathabhanga I	108.3	Koch Behar II	115.8	Koch Behar I
11	128.8	Tufanganj I	109.9	Tufanganj I	125.4	Mathabhanga II
12	130.3	Tufanganj II	185.3	Mekhliganj	134.4	Haldibari

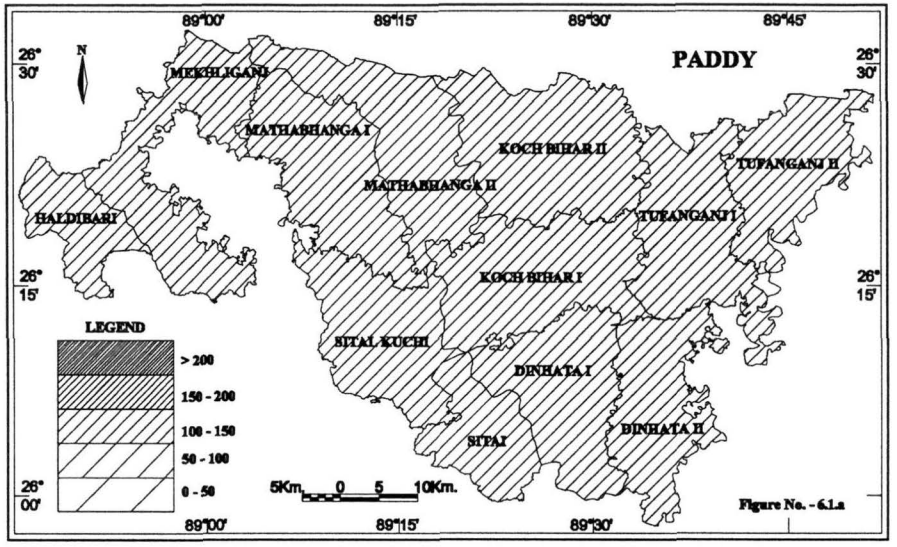
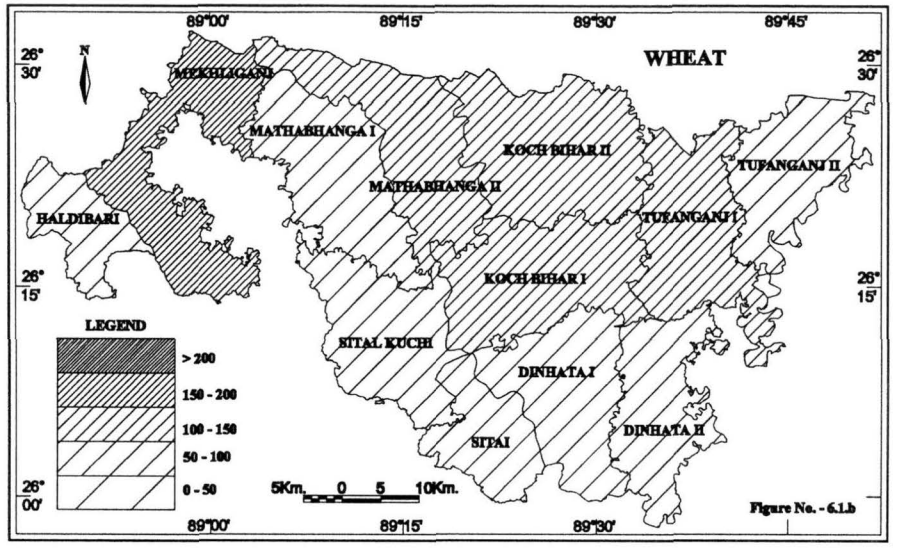


Figure No. - 6.1.a



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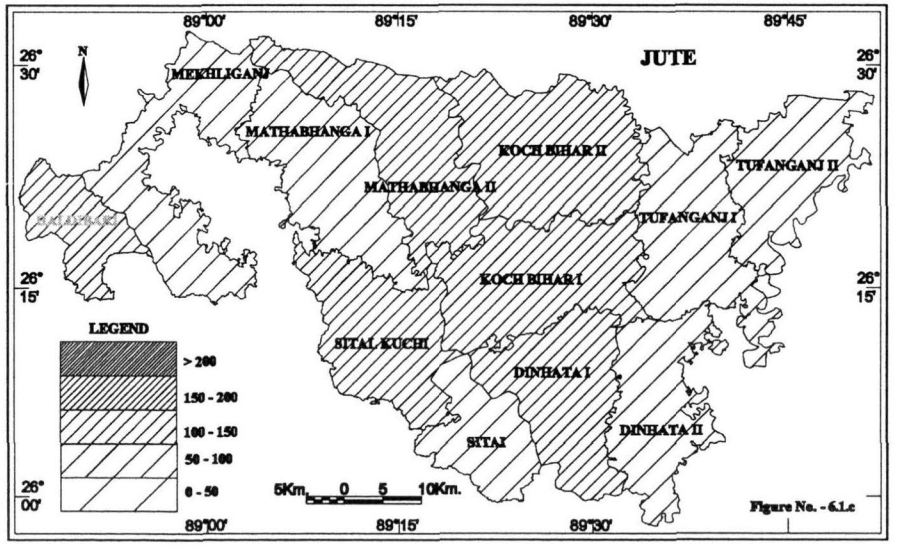

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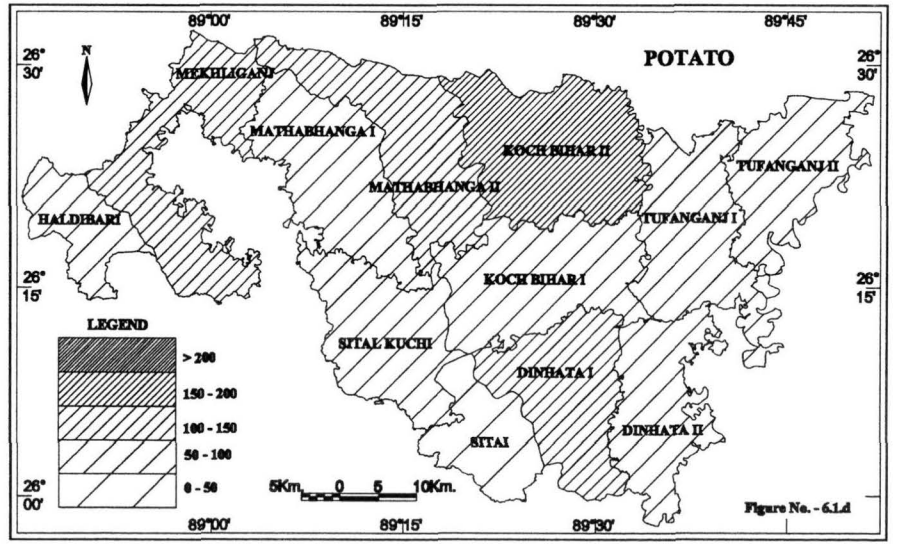


Figure No. - 6.1.d

Paddy is the first priority food crops of the district. It is grows in all the blocks. The most efficient block in paddy cultivation is Mathabhanga II while the least is Tufanganj II. Five blocks namely Haldibari, Dinhata I, Koch Bihar I, Mekhliganj and Koch Bihar II identified as high efficient blocks while three blocks namely Sitai, Sitalkuchi, Dinhata II and Mathabhanga I, Tufanganj I and Tufanganj II are low efficient and very low efficient blocks respectively (Fig. 6.1a).

Wheat is the second major food crops of the district. The Haldibari (54.49) block identifies as most efficient block while Mekhliganj Block (185.34) ranks the least efficient block of the district in 2004-05. Other blocks namely Sitalkuchi (60.59), Dinhata II (74), Sitai (89.15), and Mathabhanaga I (89.35) are also identified as efficient blocks. Tufanganj II (95.94) and Mathabhanga II (102.48), rank moderate and Koch Bihar I (104.47), Koch Bihar II (108.28), Tufanganj II (109.96) identified as low efficient block (Fig. 6.1b).

Jute is the principal cash crop of the district grown as a kharif crop. It is cultivated in all the blocks of the district. However, in respect of productivity of jute spatial variation is apparent. Tufanganj II (61.11) identifies as the most efficient block while Haldibari (134.39) identifies as the least efficient block in terms of productivity of jute in 2004-05. Sitai (81.48), Tufanganj I (88.98), Mathabhanga I (90.72) and Mekhliganj (93.13) identify as the moderately high efficient blocks while four blocks namely Dinhata II (99.53), Koch Bihar II (100.58), Dinhata I (102.70), Sitalkuchi (106.22) rank moderately low efficient blocks. Koch Bihar I (115.84), Mathabhanga II (125.37) and Haldibari (134.39) ranks as low (Fig. 6.1c).

Table 6.2
Crop yield and yield concentration indices ranking co-efficient 2004-2005

Rank	Potato		Rank	Vegetables		Spices	
	Indices	Block		Indices	Block	Indices	Block
1	38.2	Sitai	1	75.35	Sitalkuchi	78.67	Sitalkuchi
2	52.1	Sitalkuchi	2	81.7	Mekhliganj	84.27	Mekhliganj
3	59.8	Haldibari	3	87.79	Sitai	84.61	Koch Behar I
4	69.1	Mathabhanga I	4	95.45	Dinhata II	85.13	Dinhata II
5	71.9	Dinhata II	5	96.54	Koch Behar II	88.20	Dinhata I
6	85.7	Tufanganj I	6	96.76	Koch Behar I	92.24	Tufanganj I
7	86.0	Koch Behar I	7	98.03	Mathabhanga I	93.95	Koch Behar II
8	89.9	Tufanganj II	8	98.42	Tufanganj I	98.44	Mathabhanga II
9	122.9	Dinhata I	9	101.2	Mathabhanga II	98.67	Sitai
10	136.9	Mathabhanga II	10	109.2	Dinhata I	99.21	Mathabhanga I
11	144.3	Mekhliganj	11	117.7	Tufanganj II	104.8	Tufanganj II
12	161.6	Koch Behar II	12	151.1	Haldibari	246.8	Haldibari

CROP YIELD & CONCENTRATION INDICES IN KOOCH BIHAR DISTRICT

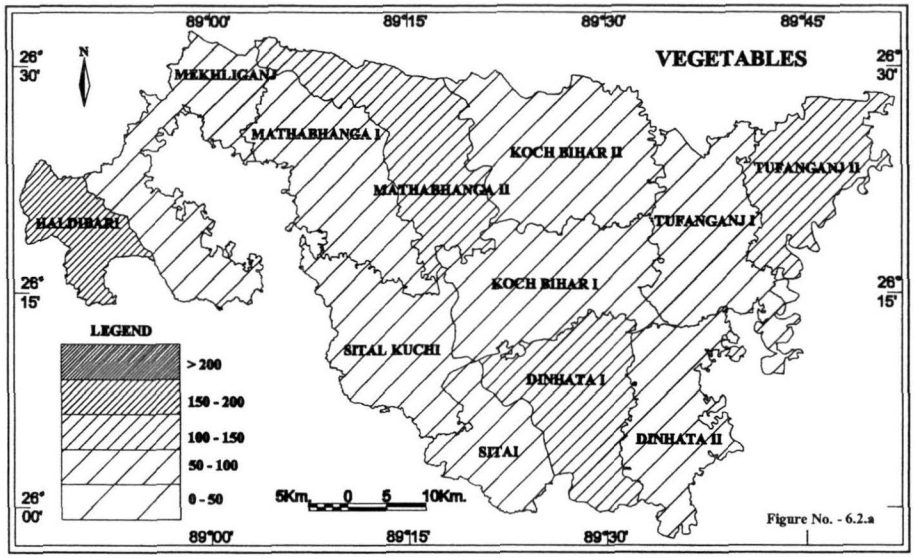


Figure No. - 6.2.a

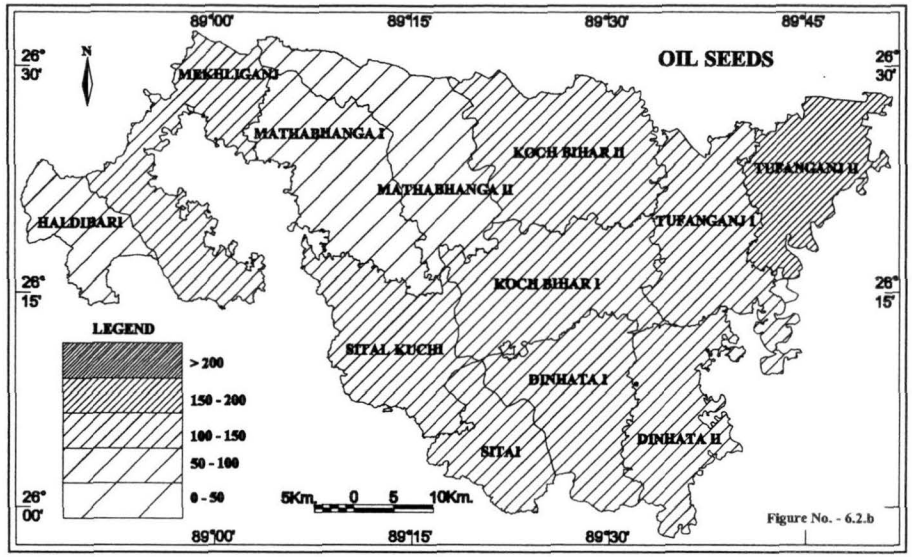


Figure No. - 6.2.b

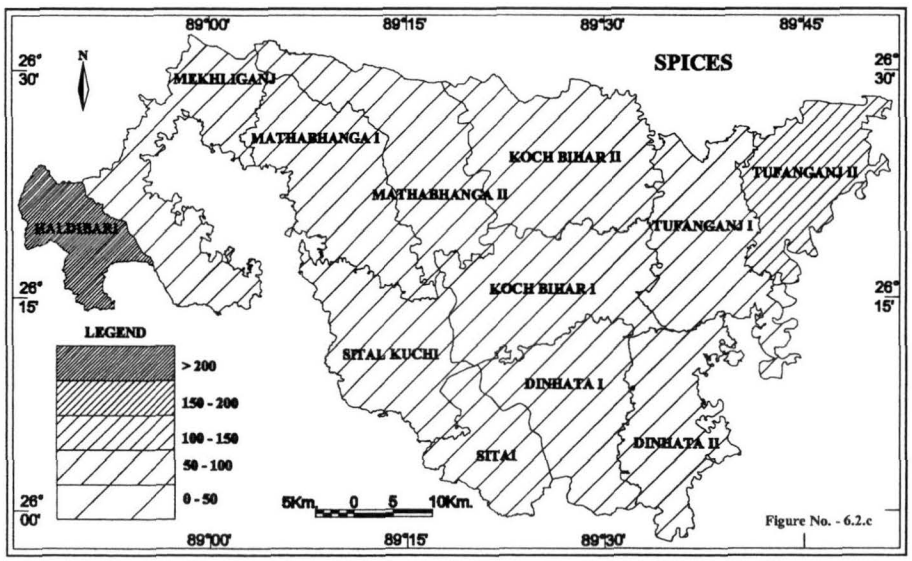


Figure No. - 6.2.c

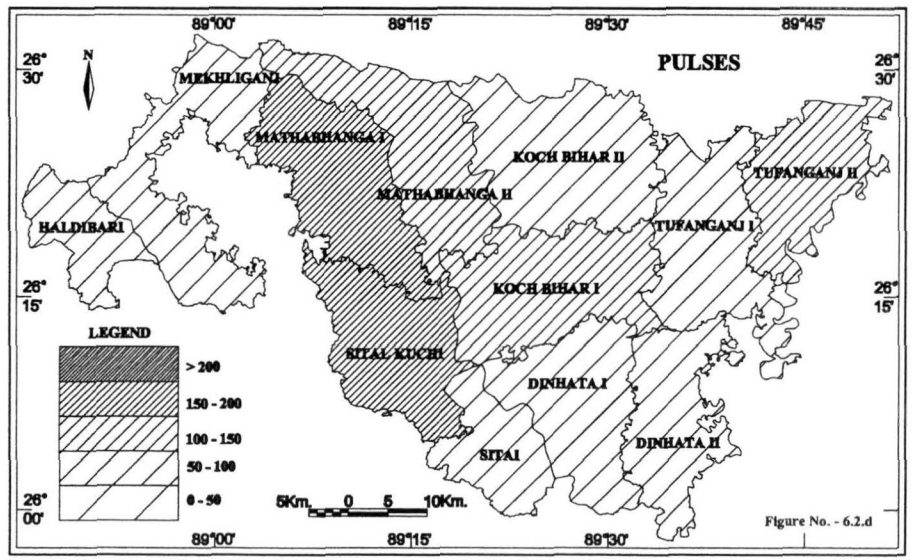


Figure No. - 6.2.d

Potato has now become one of the significant cash and vegetable crop in the district. The study reveals that Sitai, Sitalkuchi, Haldibari, Mathabhanga I and Dinhata II are the high efficient blocks while Dinhata I, Mathabhanga II, Mekhliganj and Koch Bihar II identified as low efficient blocks in 2004-05. Only three blocks namely Tufanganj I, Koch Bihar I and Tufanganj II have identified as moderately efficient blocks (Fig.6.1d).

In terms of **vegetables** productivity Sitalkuchi ranks the most efficient block while Haldibari ranks the least efficient block in the district. In all the blocks of the district throughout the year different types green vegetables are grown. Green vegetables are the major source of money to farmers (6.2a).

Table 6.3
Crop yield and yield concentration indices ranking co-efficient 2004-2005

Rank	Pulses		Oil seeds		Tobacco	
	Indices	Block	Indices	Block	Indices	Block
1	50.8	Dinhata I	56.21	Haldibari	52.92	Mathabhanga II
2	54	Haldibari	84.67	Mathabhanga I	68.49	Dinhata II
3	63.7	Tufanganj I	97.63	Mathabhanga II	96.01	Mathabhanga I
4	65.0	Mekhliganj	106.0	Sitai	124.1	Koch Behar I
5	71.6	Dinhata II	112.4	Sitalkuchi	141	Dinhata I
6	75.4	Sitai	108.3	Koch Behar II	149	Mekhliganj
7	84.2	Koch Behar II	129.3	Mekhliganj	165.5	Sitalkuchi
8	107.8	Mathabhanga II	131.9	Koch Behar I	414.9	Sitai
9	122.2	Tufanganj II	133.2	Dinhata II	NIL	NIL
10	142.4	Koch Behar I	137.3	Tufanganj I	NIL	NIL
11	153.3	Sitalkuchi	142.5	Dinhata I	NIL	NIL
12	170.9	Mathabhanga I	181.4	Tufanganj II	NIL	NIL

In terms of productivity of **pulses**, Dinhata I (50.79) identified as the most efficient block and Mathabhanga I (170.91) has identified as the least efficient block in the district in 2004-05. The productivity indices calculated are Haldibari (54.00), Tufanganj I (63.67), Mekhliganj (65.03), Dinhata II (71.65), Sitai (75.4), Koch Bihar II (84.24), Mathabhanga II (107.87), Tufanganj II (122.17), Koch Bihar I (142.44), Sitalkuchi (153.33). Hence, it is clear that more than 50 % of the blocks have identified as the low efficient blocks in the district in 2004-05 (6.2d).

Haldibari (56.21) identified as the most efficient block in the district in terms of **Oilseeds** productivity while Tufanganj II (181.4) identified as the least efficient block in the

district in 2004-05. The productivity indices of oilseeds for other blocks are Mathabhanga I (84.67), Mathabhanga II (97.63), Sitai (106.03), Koch Bihar II (108.30), Sitalkuchi (112.42), Mekhliganj (129.32), Koch Bihar I (131.97), Dinhata II (133.21), and Tufanganj I (137.30), Dinhata I (142.49). This indicates that more than 85 percent of the blocks identified as the very low efficient blocks in the district in 2004-05 (6.2b).

In terms of the productivity of spices, Mathabhanga II block was the most efficient in tobacco production during the year 2004-05 while Sitai is the least efficient block. Dinhata II and Mathabhanga I have found as highly efficient in spices production during the period.

6.3 Assessment of agricultural efficiency:

Bhatia's method (1967) has applied to assess the agricultural efficiency (AE) of different blocks of Koch Bihar district for two different periods i.e., 1980-81 and 2004-05. Twenty numbers of crops for the both period assessed for each of the 12 blocks. The analytical findings have been represented in table 6.4 and diagrammatically represented in figures 6.3a and 6.3b.

The figure 6.3a demonstrates the AE value for the period 1980-81 which reveals that Koch Bihar I block was agriculturally the most efficient block of Koch Bihar district while there were four blocks namely Mekhliganj, Haldibari, Sitalkuchi, Sitai identified as least efficient blocks in the district. While the figure 6.3b show the spatial pattern of AE for the year 2004-05 which indicates that six blocks namely Haldibari, Koch Bihar I, Koch Bihar II, Tufanganj I, Tufanganj II, Dinhata I agriculturally most efficient in the district while only block namely Mathabhanga II ranks the least efficient block in the district.

It is also observed that Tufanganj II Block is the only block, which is least diversified in agriculture, is the most efficient while Koch Bihar II and Dinhata I are high diversified as well as efficient blocks. Only three blocks namely Haldibari, Koch Bihar I and Tufanganj I show that these three blocks are moderately diversified but most efficient. The least diversified block identified as the most efficient is because the area under irrigation is not significantly developed; as a result, the block is less developed in agriculture and cultivates only one or two crops mostly in the agriculture year. On the other hand, blocks

with high diversified as well as efficient in agriculture are mainly due to higher percentage of net irrigated to the total net sown area in these blocks.

In case of least efficient block Mathabhanga II block experienced as moderate diversified due to the fact that other factors like soil fertility, lack of proper management as well as poor road and transport network could not help much in raising the agricultural productivity in the block.

It is clear from the above table and figures that the blocks, which scored higher values of AE have registered maximum increase of it during the period of study except the Dinhata block which showed marginal increase with higher A.E. value. Out of the 12 blocks of the district 11 blocks registered increase in A.E. value indices except one block namely Mathabhanga II registering fall of A.E. index value from 100.95 (in 1980-81) to 89.23 (2004-05) during the study period.

The outstanding increase in index value of agricultural efficiency is observed in Haldibari block since this block started from the lowest value of A.E. (72.01) and has been able to accord the highest increase of the index value of A.E. (112.01) during the study period.

Table 6.4 Agricultural efficiency

Sl No	Blocks	$E_{ij} = I_{ij} \times C_{ij}$	
		1980-1981	2004-2005
1	Mekhliganj	93.85	99.15
2	Haldibari	72.01	112.01
3	Mathabhanga 1	99.47	100.20
4	Mathabhanga II	100.95	89.23
5	Sitalkuchi	92.28	96.05
6	Koch Bihar I	105.53	110.09
7	Koch Bihar II	102.47	108.52
8	Tufanganj I	102.25	108.77
9	Tufanganj II	100.35	107.11
10	Dinhata I	102.43	104.56
11	Dinhata II	95.99	101.61
12	Sitai	88.57	95.24
Mean		*96.94*	*102.71*
SD		2.53	*1.05*
Co-efficient of variation % (CV)		2.61	*1.02*

AGRICULTURAL EFFICIENCY IN KOCH BIHAR DISTRICT

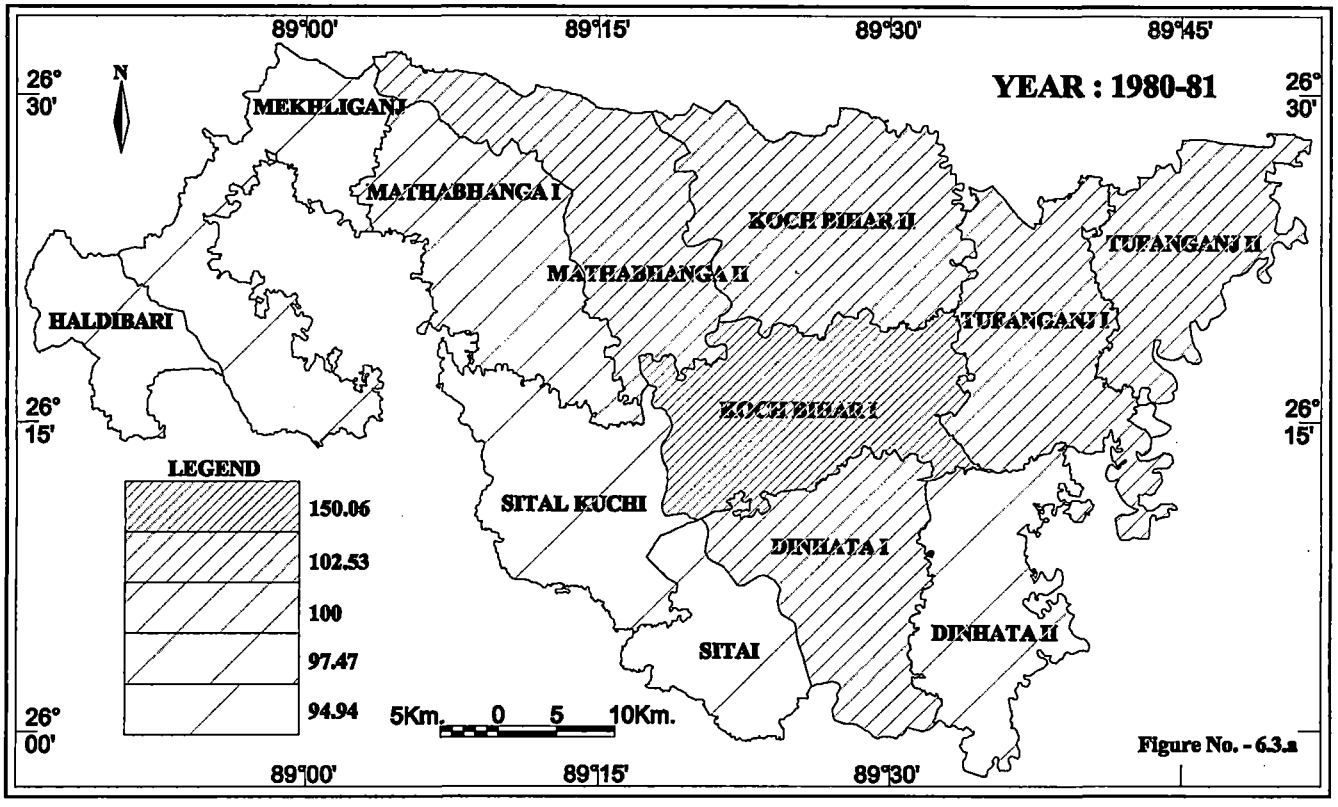


Figure No. - 6.3.a

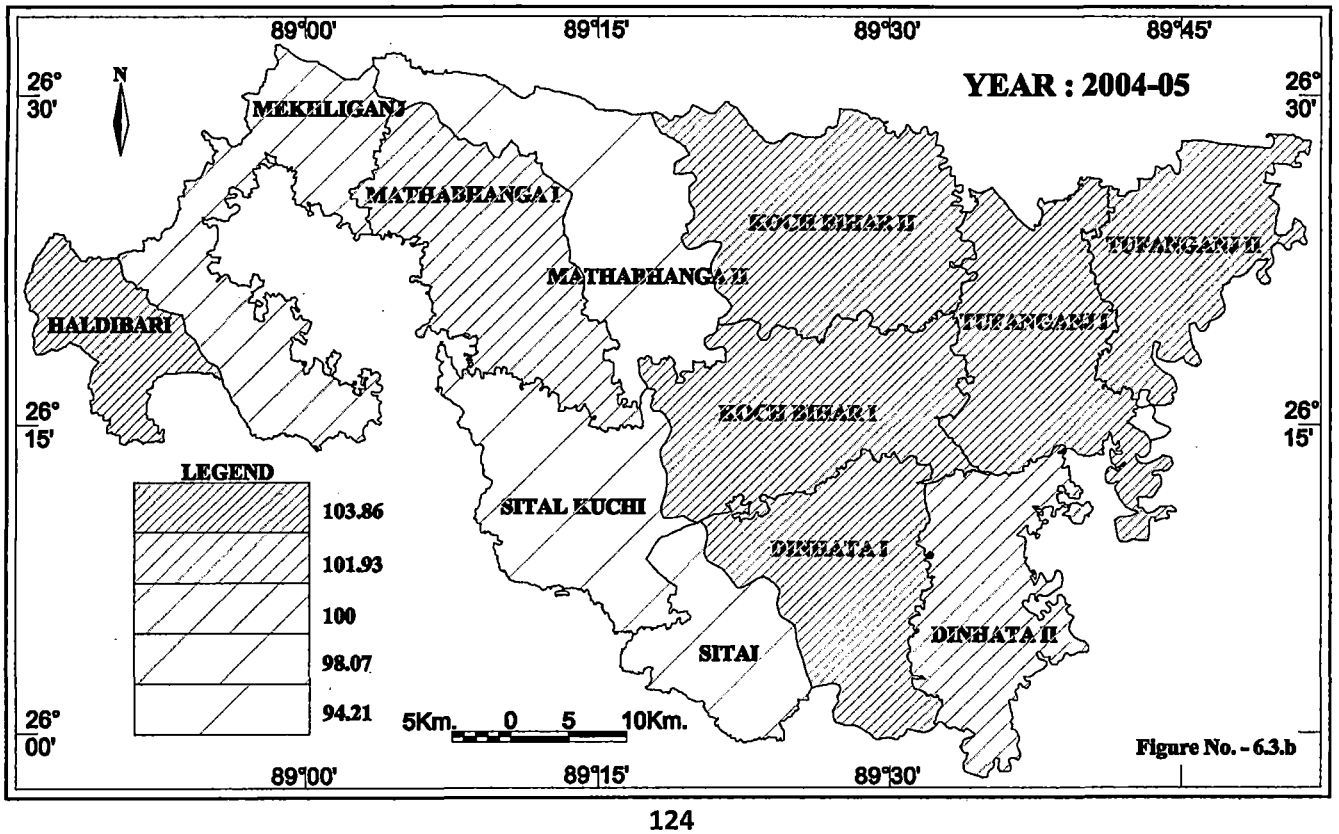


Figure No. - 6.3.b

6.3.1 Agricultural efficiency assessment based on P/A ratio

B.N. Sinha (1968) used simple process of per unit area productivity i.e., the P/A ratio while measuring the agricultural efficiency in India. This is simple but one of the most efficient tool for measuring the agricultural efficiency i.e., agricultural productivity. He assumed that total per hectare outturn as a tool for assessing efficiency without considering the factors of input and output. He also assumed that the agricultural efficiency is not a static factor rather a highly dynamic one, subjected to frequent changes. He also believes that here is no limit to per hectare production with the application of modern scientific tools and techniques.

Attempt been made to assess the efficiency of 21 principal crops grown in Koch Bihar district. The principal crops grouped into cereals, pulses, oilseeds and money crops. Average per hectare yield been calculated at the block level for the cereals, pulses, oilseeds for the year 1980-81 and 2004-05.

6.3.1.1 Cereal efficiency

The agricultural efficiency of cereals has computed in terms of Z score for four cereals and the result has multiplied by the corresponding area under cereals. The result obtained are ranked in descending order for positive values and ascending order for negative values and represented in table 6.5.

Table 6.5 reveals that Koch Bihar I ranked the topmost position in terms of cereals efficiency with the index value of 1033.19 whereas Mathabhanga II observed least cereal efficiency with an index value of -270.03 during 1980-81. Out of 12 blocks of the district, seven blocks showed positive index values indicate that 58.33 percent of the total blocks were efficient in cereal production. Assured irrigation, use of HYVs, and application of adequate fertilisers, manures and pesticides favoured high degree of cereals efficiency in the blocks noted above (6.4a).

Haldibari ranks the topmost position and Koch Bihar I rank the lowest in terms of cereals efficiency during the year 2004-05. Out of twelve blocks of the district six blocks

showing positive index values of cereal efficiency, indicate that 50 percent of the total blocks are efficient in cereal production (6.4b).

Table 6.5 Cereal efficiency of 1980-81 & 2004-05

1980-81			2004-05		
Rank	ZC*AC	Blocks	Rank	ZC*AC	Blocks
1	1033.19	Koch Bihar I	1	259.96	Haldibari
2	428.42	Koch Bihar II	2	161.16	Sitai
3	356.73	Tufanganj I	3	138.38	Tufanganj II
4	331.58	Dinhata I	4	93.75	Mathabahanga I
5	147.5	Mekhliganj	5	40.92	Tufanganj I
6	109.6	Sitalkuchi	6	17.99	Mekhliganj
7	93.08	Sitai	7	-52.84	Dinhata I
8	-195.23	Tufanganj II	8	-121.76	Sitalkuchi
9	-197.99	Haldibari	9	-195.18	Koch Bihar I
10	-234.60	Dinhata II	10	-280.85	Dinhata II
11	-234.87	Mathabahanga I	11	-327.23	Mathabhanga II
12	-270.03	Mathabhanga II	12	-337.13	Koch Bihar II

6.3.1.2 Pulses efficiency

For the determination of efficiency in the cultivation of pulses in Koch Bihar district *Maskalai*, *Masur*, *Khesari* has been taken into account (table 6.6).

Period 1980-81:

For all the blocks ZP*AP has been computed and it has been found that 41.67% blocks have figures of plus values which indicate their efficiency is above the district's average. Among this Koch Bihar I ranked first with the index value of 15.52 followed by Mathabhanga II (8.88), Dinhata II (7.57), and Tufanganj II (5.05), Tufanganj I (2.01). Except Mathabhanga II, all are fall under Torsa-Kaljani- Raidak basin whereas Mathabhanga II is on the Mansai basin.7 or 58.33 percent of the blocks have negative values which indicate the below average of the district. The lowest rank was in the Mathabhanga I whose index value was (-) 8.76. The negative values are arranged in ascending order of Koch Bihar I (-.71), Sitalkuchi (-3.29), Sitai (-3.96), Haldibari (-4.40), Mekhliganj (-6.43), and Dinhata I (-6.60) (Fig. 6.5a).

CEREALS EFFICIENCY IN KOCH BIHAR DISTRICT

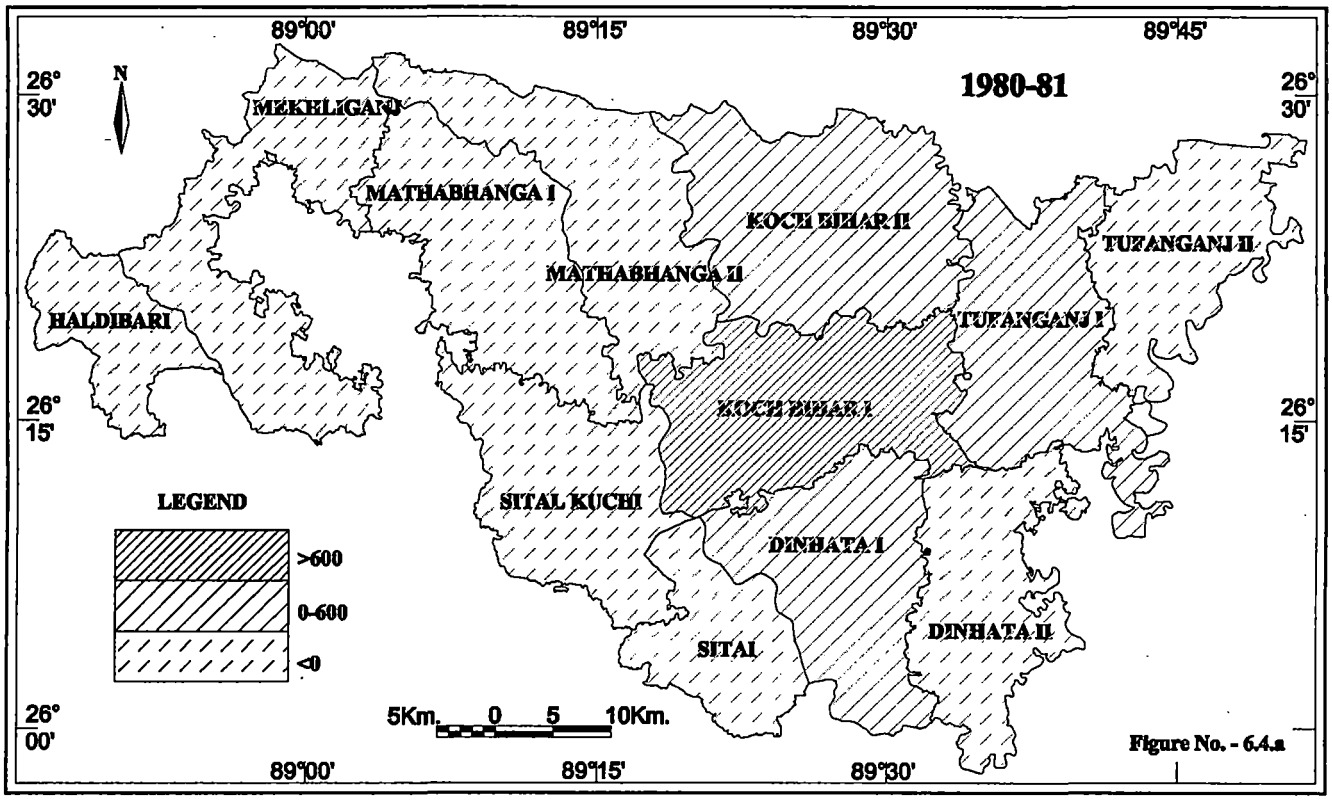


Figure No. - 6.4.a

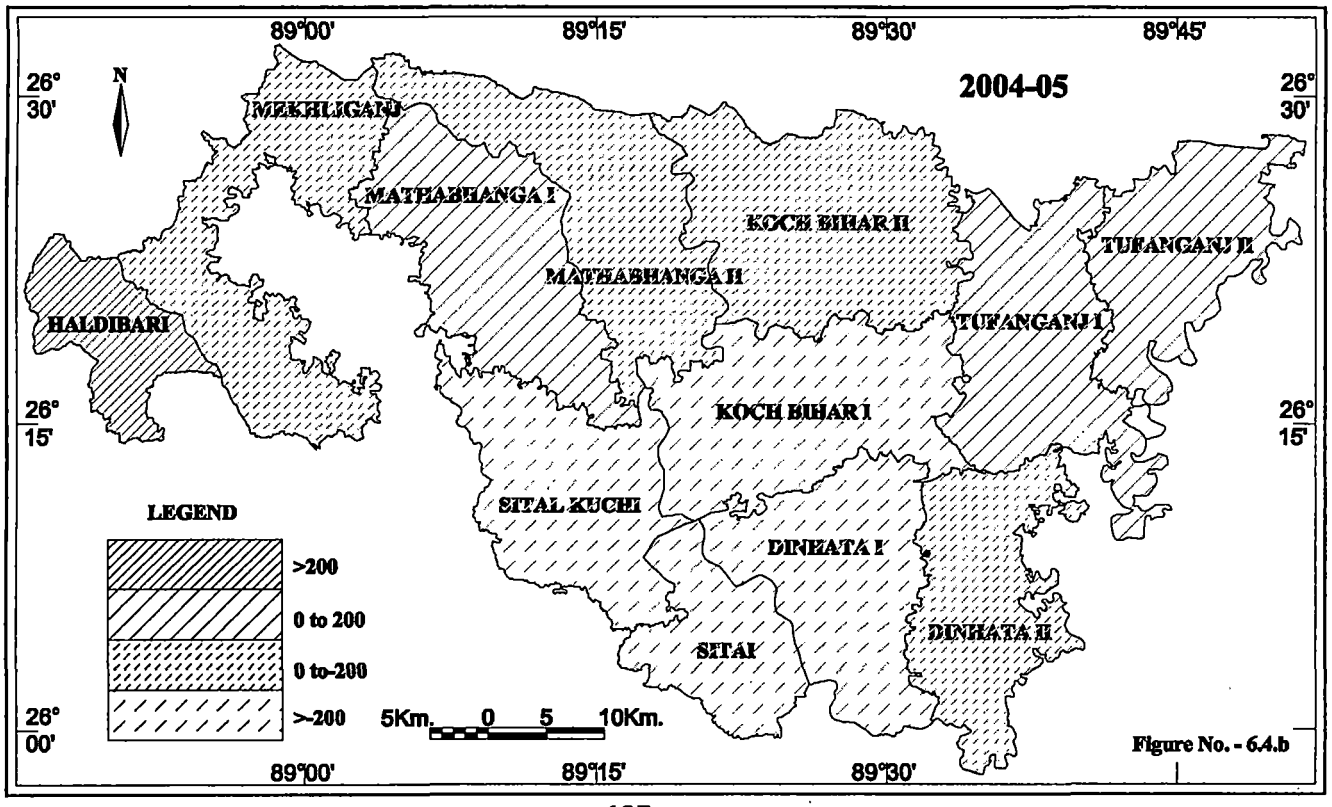


Figure No. - 6.4.b

Period 2004-05

On the contrary, only two blocks namely Mekhliganj (2.19), and Dinhata I (.35) show positive efficiency and it is only 16.67% of total blocks. Though these are positive to district average, their index values of efficiency are very low. The negative index value ranges between -0.60 (Sitai) to -17.12 (Tufanganj II). The other blocks which show negative index value are as follows Haldibari (-1.67), Dinhata II (-2.05), Koch Bihar II (-2.52), Tufanganj I (-2.54), Mathabhanga II (-5.83), Sitalkuchi (-11.41), Mathabhanga I (-14.18), and Koch Bihar I (15.01) (Fig. 6.5b).

From the above comparison, it is clear that a drastically change in pulses efficiency during the study period 1980 -81 to 2004-05. In 1980-81 Mekhliganj and Dinhata I was least efficient whereas in 2004-05 these blocks show highest positive index value.

Table 6.6 Pulses efficiency of 1980-81 & 2004-05

1980-81			2004-05		
Rank	ZP*AP	Blocks	Rank	ZP*AP	Blocks
1	15.52	Koch Bihar I	1	2.19	Mekhliganj
2	8.8	Mathabhanga II	2	0.35	Dinhata I
3	7.57	Dinhata II	3	-0.60	Sitai
4	5.05	Tufanganj II	4	-1.67	Haldibari
5	2.01	Tufanganj I	5	-2.05	Dinhata II
6	-0.71	Koch Bihar II	6	-2.52	Koch Bihar II
7	-3.29	Sitalkuchi	7	-2.54	Tufanganj I
8	-3.96	Sitai	8	-5.83	Mathabhanga II
9	-4.40	Haldibari	9	-11.41	Sitalkuchi
10	-6.43	Mekhliganj	10	-14.18	Mathabhanga I
11	-6.60	Dinhata I	11	-15.01	Koch Bihar I
12	-8.86	Mathabhanga I	12	-17.12	Tufanganj II

6.3.1.3 Oilseeds Efficiency

For the determination of efficiency in the cultivation of Oilseeds in Koch Bihar district rapeseed and mustard, linseeds, *til*, *niger* has been taken into account (table 6.7).

Period 1980-81

PULSES EFFICIENCY IN KOCH BIHAR DISTRICT

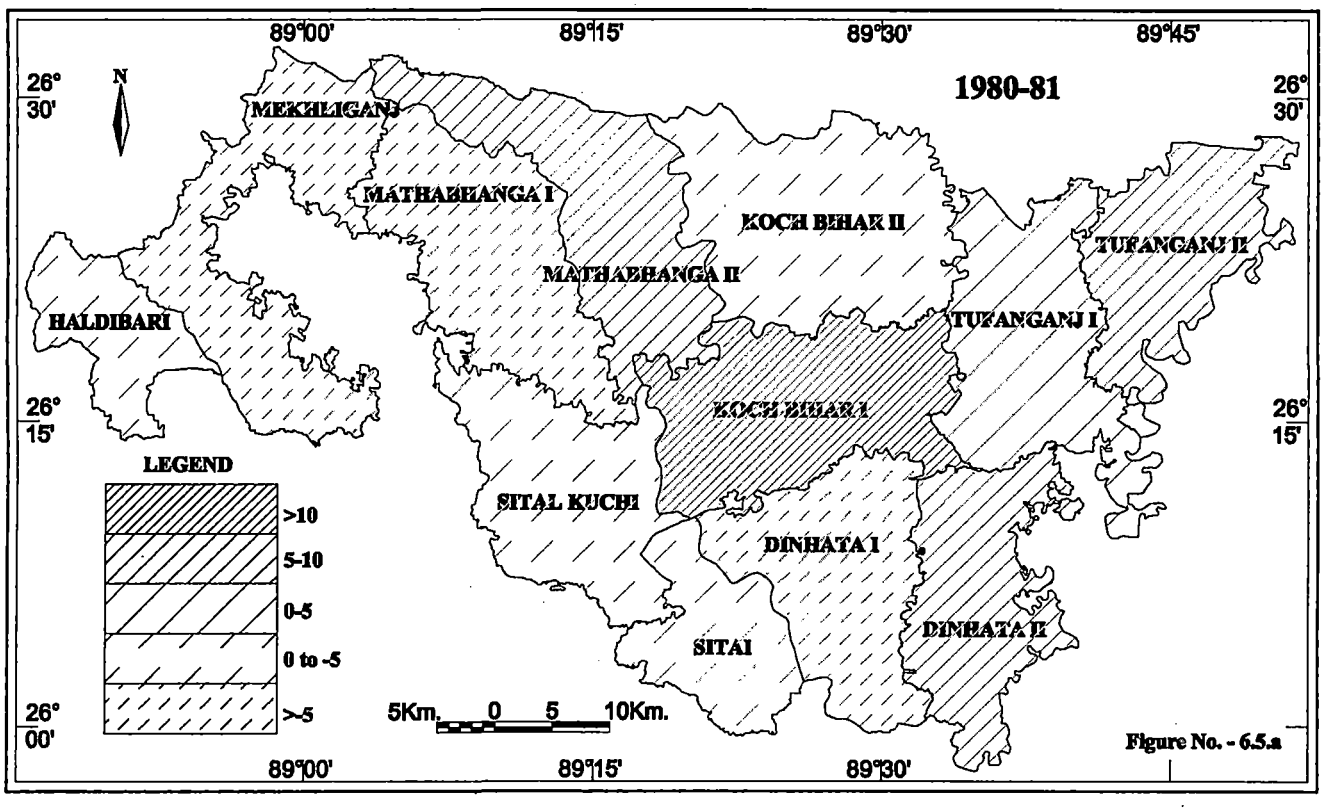


Figure No. - 6.5.a

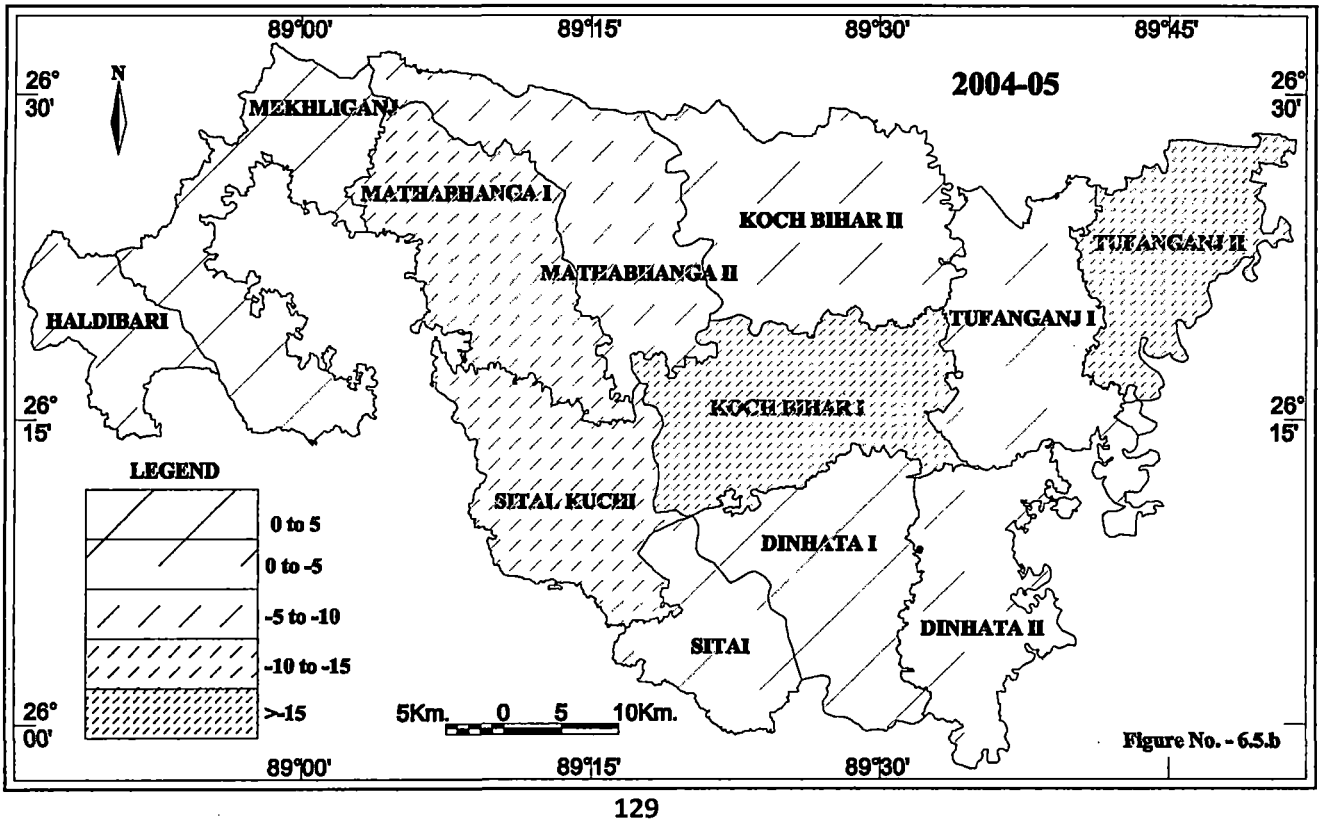


Figure No. - 6.5.b

For all the blocks ZO*AO has been computed and it has been found that 33.33% blocks have figures of plus values which indicate their efficiency is above the district's average. In these Tufanganj I ranked first with the index value of 18.24 followed by Sitalkuchi (3.55), Koch Bihar II (3.32), Dinhata I (2.24). Except Sitalkuchi all are fall under Torsa-Kaljani- Raidak basin whereas Sitalkuchi is on the Mansai basin. 66.67% of the blocks have negative values which indicate the below average of the district. The lowest rank was in the Haldibari whose index value was -13.68. The negative values are arranged in ascending order of Sitai (0-.88), Mathabhanga I (-1.95), Mekhliganj (-2.37), Koch Bihar I (-2.65), Dinhata II (-3.18), Mathabhanga II (-8.37), Tufanganj I (-13.43), Haldibari (-13.68) (Fig. 6.6a).

Period 2004-05

On the contrary, seven blocks namely Mathabhanga II (96.0) Dinhata I (22.50). Dinhata II (18.32). Mekhliganj (17.56), Koch Bihar I (15.14), Sitalkuchi (-8.63), and Sitai (1.95) show positive efficiency and it is 58.33 percent of total blocks. Though these are positive to district average, their index values of efficiency are high. The negative index value ranges between -4.5 (Tufanganj II) to -49.13 (Koch Bihar I). The other blocks which show negative index values are as follows Haldibari (-8.56), Mathabhanga I (-27.86), Tufanganj I (-30.08) (Fig. 6.6b).

Table 6.7 Oilseeds efficiency of 1980-81 & 2004-05

1980-81			2004-05		
Rank	ZO*OC	Blocks	Rank	ZO*AO	Blocks
1	18.24	Tufanganj II	1	96.0	Mathabhanga II
2	3.55	Sitalkuchi	2	22.5	Dinhata I
3	3.32	Koch Bihar II	3	18.32	Dinhata II
4	2.24	Dinhata I	4	17.56	Mekhliganj
5	-.88	Sitai	5	15.14	Koch Bihar II
6	-1.95	Mathabhanga I	6	8.63	Sitalkuchi
7	-2.37	Mekhliganj	7	1.95	Sitai
8	-2.65	Koch Bihar I	8	-4.50	Tufanganj II
9	-3.18	Dinhata II	9	-8.56	Haldibari
10	-8.37	Mathabhanga II	10	-27.86	Mathabhanga I
11	-13.43	Tufanganj I	11	-30.08	Tufanganj I
12	-13.68	Haldibari	12	-49.13	Koch Bihar I

OIL SEEDS EFFICIENCY IN KOCH BIHAR DISTRICT

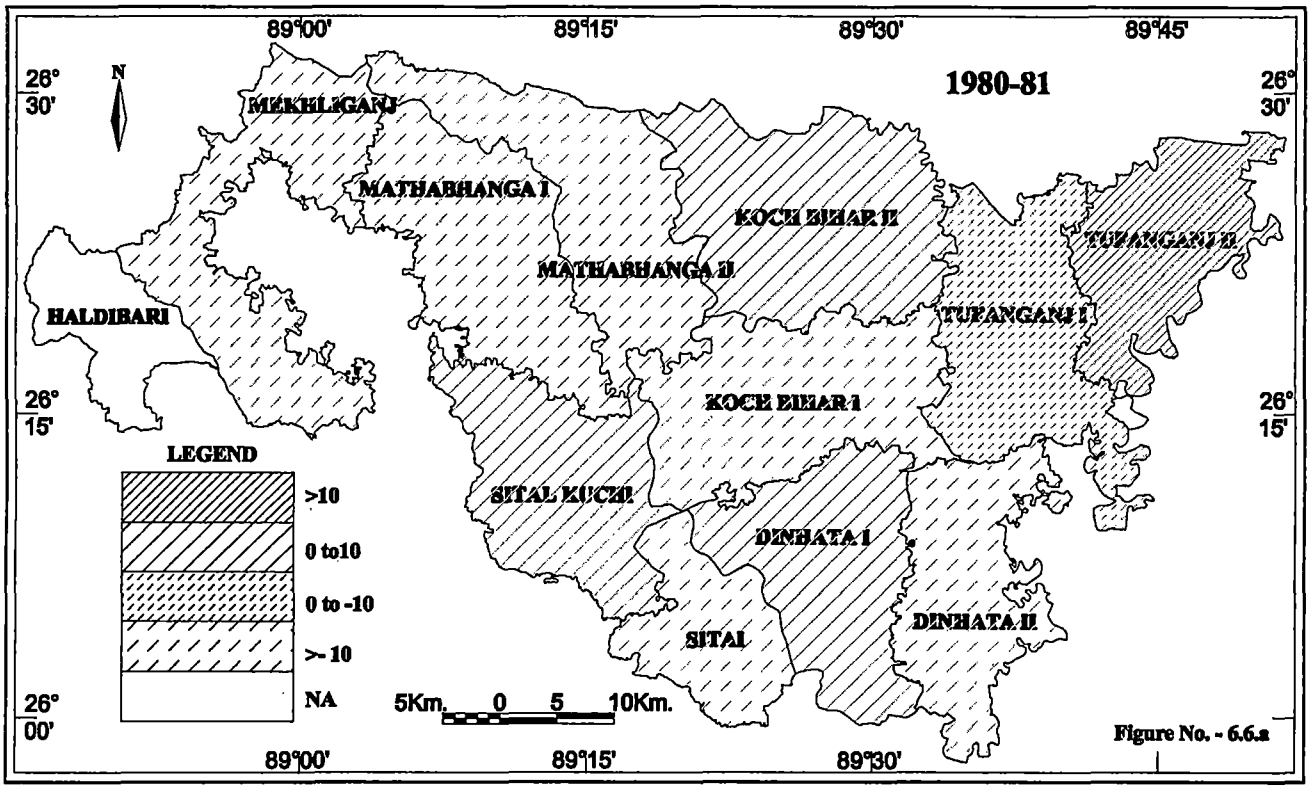


Figure No. - 6.6.a

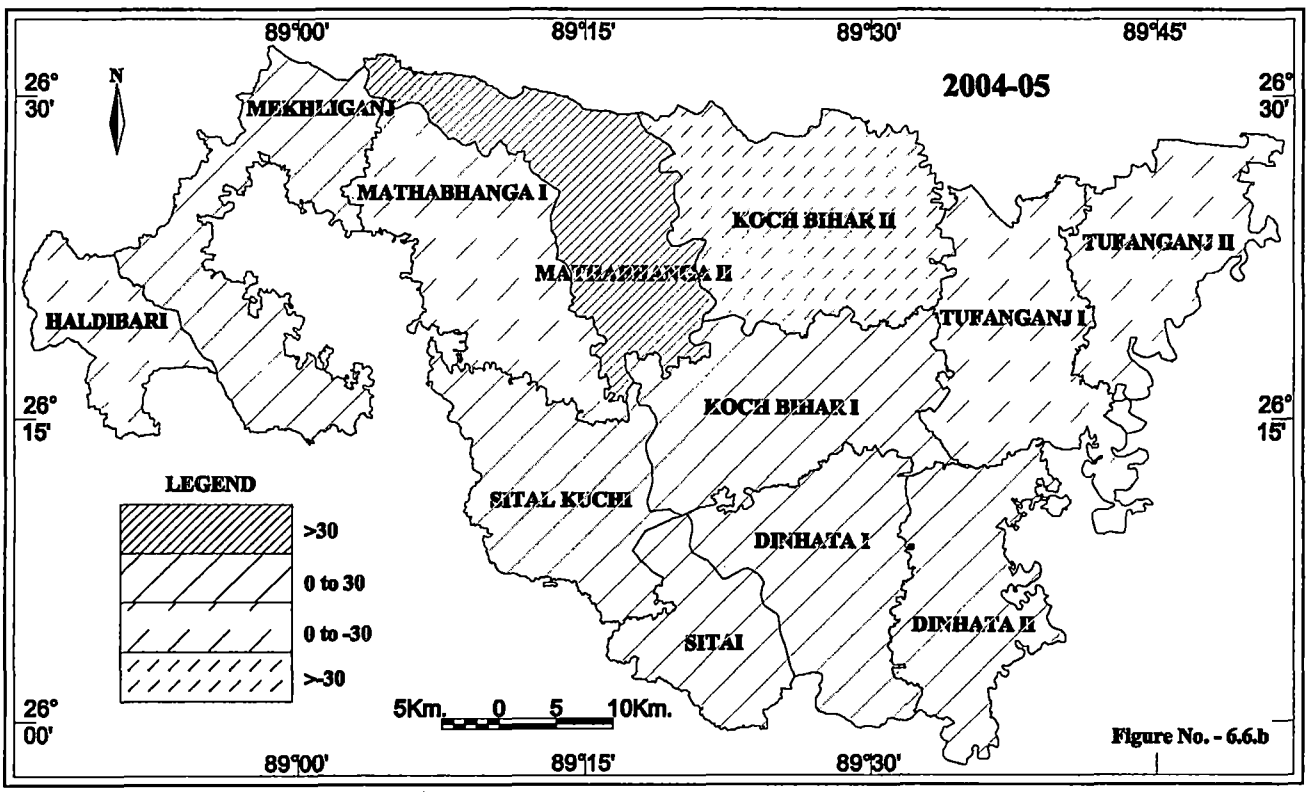


Figure No. - 6.6.b

From the above comparison, it is clear that a drastically change is observed in oilseeds efficiency during the study period 1980-81 to 2004-05. In 1980-81, four blocks identified as positive index values while these numbers have increased to six in 2004-05

6.3.1.4 Cash crop efficiency

To consider the efficiency of cash crops, five crops namely Jute, Potato, Green vegetables, Tobacco and Spices have been included and their production are converted in to price values. ZM x AM have been computed and tabulated in the following way i.e. positive values in descending order and negative values in ascending order (table 6.8).

Period 1980-81

It is evident that half of the total blocks have plus values while other 50 percent blocks have negative values. The maximum money crop efficient block during the period 1980-81 was Dinhata I (120.36) whereas the least efficient block was Tufanganj I (-138.76). The blocks which were above the district average i.e. positive values namely Haldibari (81.5), Sitai (63.05), Mathabhanga II (54.41), Dinhata II (18.56) and Sitalkuchi (6.62).On the other hand, the blocks with negative index values were Mathabhanga I (-3.55), Mekhliganj (-51.08), Tufanganj II (-59.01), Koch Bihar II(-66.2), Koch Bihar I (-135.9) (Fig. 6.7 a).

During the period, 2004-05 six (6) or 50 percent out of the total twelve (12) blocks in the district accounted for both positive and negative index values. Dinhata I (260.98) followed by Mathabhanaga I (133.98), Dinhata II (117.13), Tufanganj II (61.43), Sitalkuchi (42.06), Koch Bihar II (35.9). The least efficient block is Mekhliganj (-253.80). The other blocks which are less efficient and rank below the district average are Haldibari (-3.41), Sitai (-42.08), Sitalkuchi (-90.74), Tufanganj (-126.58) and Koch Bihar I (-139.73) (Fig. 6.7b).

From the above discussion, it has inferred that Dinhata I block has identified as the most efficient block in both periods. However, out of six positive valued blocks three (3) or 50 percent have declined in their efficiency from positive to negative efficiency. Similarly, three (3) or 50 percent negative valued blocks have shifted from negative to positive efficiency. The names of the blocks are Mathabhanga I, Tufanganj II, and Koch Bihar II.

CASH CROP EFFICIENCY IN KOCH BIHAR DISTRICT

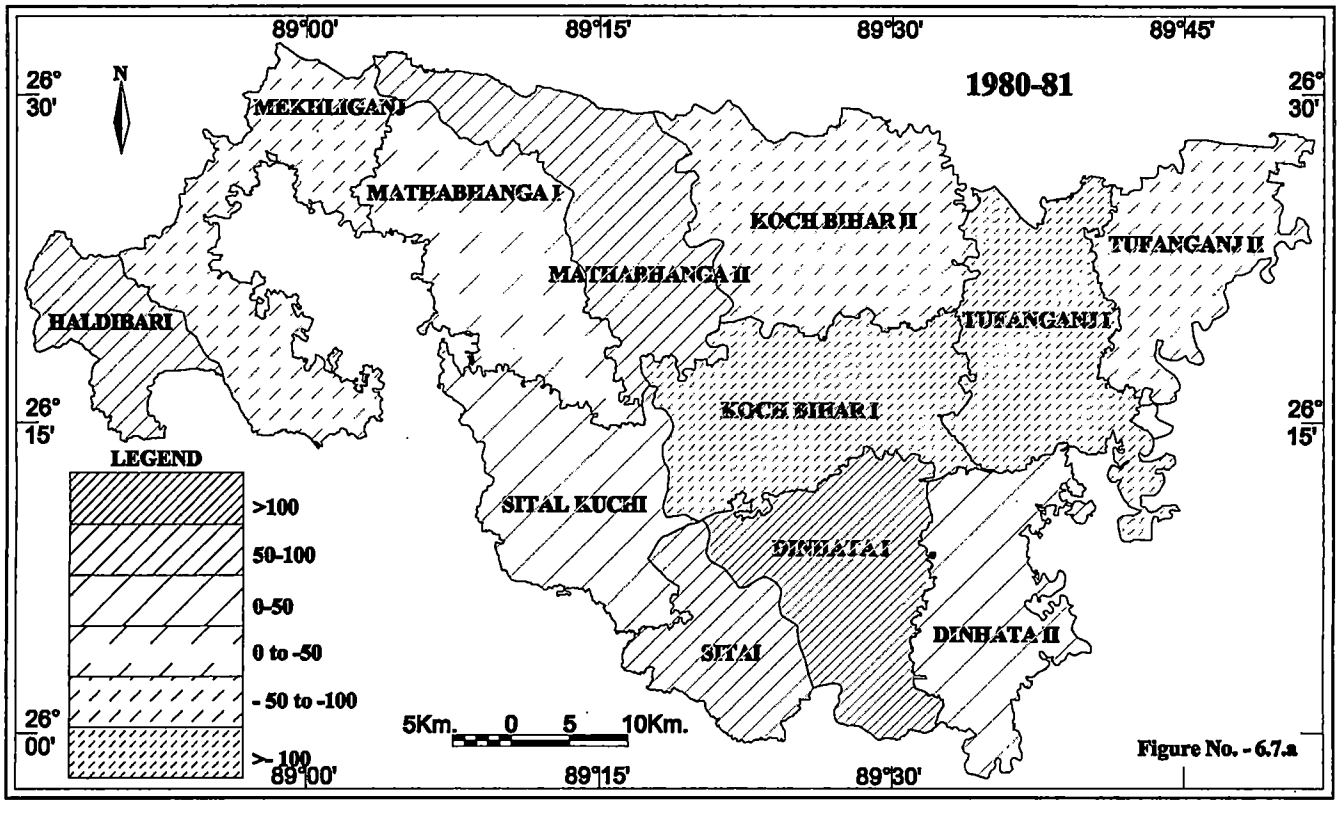


Figure No. - 6.7.a

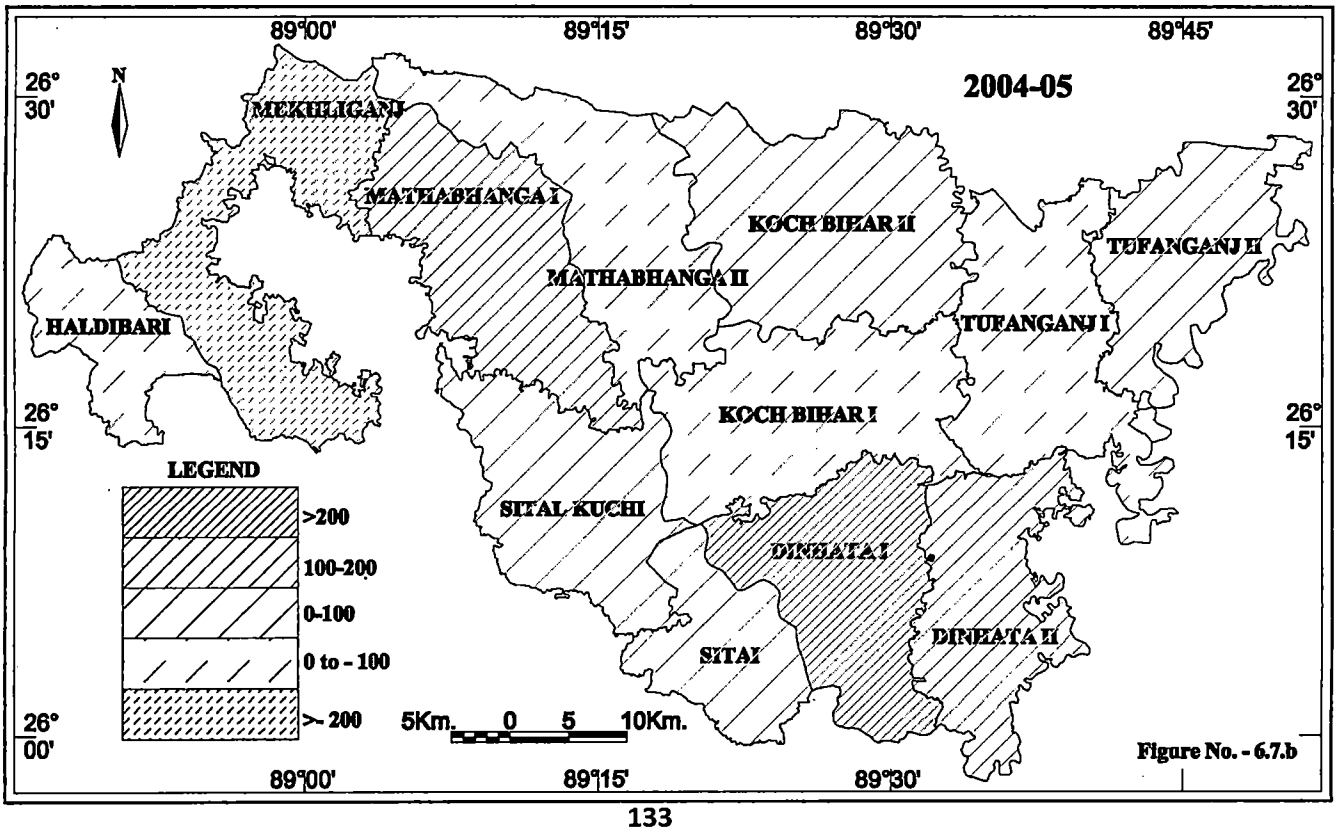


Figure No. - 6.7.b

The above study reveals that during the study period, there is a spatio-temporal variation in agricultural efficiency in the district. The study period shows that out of 12 blocks, 11 blocks identified where agricultural efficiency for twenty major crops has been increased considerably. The Haldibari block registered the highest increase and Mathabhanga I observed the lowest increase during the study period. Only one block namely Mathabhanga II in the district showed the decline in agricultural efficiency.

Table 6.8 Cash Crop efficiency of 1980-81 & 2004-05

1980-81			2004-05		
Rank	ZM*AM	Blocks	Rank	ZM*AM	Blocks
1	120.36	Dinhata I	1	260.98	Dinhata I
2	81.50	Haldibari	2	133.98	Mathabhanga I
3	63.05	Sitai	3	117.13	Dinhata II
4	54.41	Mathabhanga II	4	61.43	Tufanganj II
5	18.56	Dinhata II	5	42.06	Sitalkuchi
6	6.62	Sitalkuchi	6	35.9	Koch Bihar II
7	-3.55	Mathabhanga I	7	-3.41	Haldibari
8	-51.08	Mekhliganj	8	-42.08	Sitai
9	-59.01	Tufanganj II	9	-90.74	Mathabhanga II
10	-66.2	Koch Bihar II	10	-126.58	Tufanganj I
11	-135.9	Koch Bihar I	11	-139.73	Koch Bihar I
12	-138.76	Tufanganj I	12	-253.8	Mekhliganj

6.4 Growth trend analysis gross production

The spatio-temporal variations in terms of gross production of selected major crops at block level in the Koch Bihar district has been analysed by calculating the compound growth rates in order to expound the growth trends of cropping pattern. The compound growth rate for the different crops has calculated by using the following formula:

$$r = [(\sqrt[n]{P_n / P_o}) - 1] * 100 \% \qquad \text{.....6.1}$$

Where, r = Compound growth rate; n = No. of years; P_n = Component gross production of the final year and P_o = Component gross production of the initial year

6.4.1 *Aus* paddy

The *aus* paddy production has shown a negative growth rate of 5.46% annually for the district as a whole. It has seen that *aus* paddy witnessed declining trend in all the blocks

of the district during the study period (Table 6.9 and Fig.). The maximum decline has noticed in Dinhata I (22.26) while the minimum fall has found in Sitalkuchi (1.01).

Table: 6.9 Production (in metric tons) of major crops in Koch Bihar district

Sl No	Crops	1980-81	1985-86	1990-91	1995-96	2000-01	2004-05
1	Aus	69200	61200	105400	62800	48700	17007
2	Aman	208200	228900	278000	285500	394900	366060
3	Boro	339	1200	18500	35100	73700	88970
4	Paddy	277700	291300	401900	383400	517300	472037
5	Wheat	20100	28700	22500	29500	49800	33380
6	Maize	100	40	10	25	10	11160
7	Small Millets	1000	1263	2319	700	490	470
8	Masur	980	143	1070	375	520	320
9	Maskalai	1050	140	3242	3750	3680	3360
10	Khesari	1950	2770	990	490	2480	620
11	Moong	25	145	10	97	220	165
12	Matar	-	50	3	8	60	4
13	Kulti	40	65	80	58	12	31
14	Rapeseed & Mustard	2200	1140	2560	3500	5100	9445
15	Linseed	200	1410	250	500	220	190
16	Til	300	299	662	100	333	518
17	Niger	800	600	1809	1800	1960	2870
18	Jute	97190	510650	86166	111240	140868	112174
19	Others fibers	9468	4680	1746	2106	3258	612
20	Potato	10590	18500	57200	172500	281700	427920
21	Green Vegetables	92330	2100	3200	5800	6500	804590
22	Chilies	900	527	2744	5100	5440	11160
23	Ginger	500	461	536	700	1110	1050
24	Turmeric	105	465	487	550	780	730
25	Areca nut	1155	1579	1600	1150	1500	5730
26	Spices	2660	-	-	-	8830	18670
27	Tobacco	14300	10800	8900	7500	4400	21427
28	Miscellaneous	35000	31400	69300	185800	292600	165000

Source: i) District Statistical Hand Book, Bureau of Applied Economics and Statistics, Govt. of West Bengal
ii) District Agricultural Annual Plan, Office of the Principal Agriculture Officer, Koch Bihar.

6.4.2 *Aman* paddy

The compound growth rates of production of important crop groups in different blocks show that *aman* record an increase of 2.28% per annum at district level. The spatial variations at block levels have assessed during the study period. The Dinhata II block has shown the highest increase (4.02%) in this regard. The lowest positive compound growth rate has observed in Mathabhanga II block (0.34%). The other blocks showing higher growth

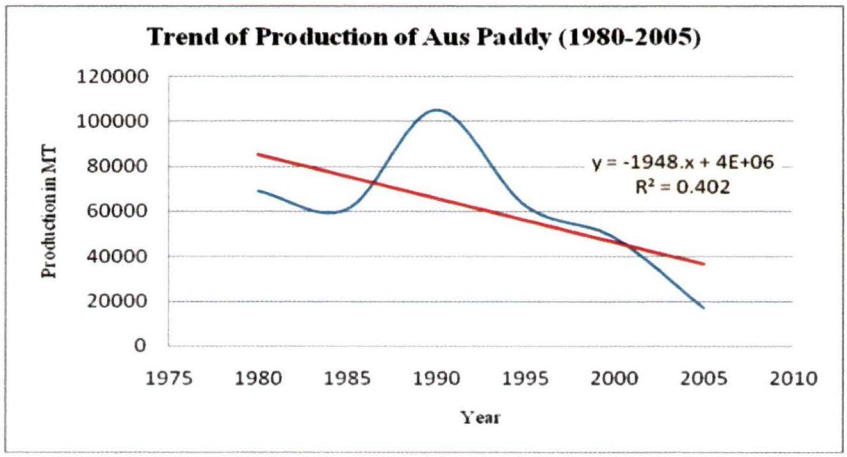


Figure 6.8 Production trend of Aus paddy

rates than district averages are Sitai (3.24%), Tufanganj II (2.91%), Tufanganj I (2.86%), Haldibari (2.62%), Sitalkuchi (2.55%), Dinhata I (2.31%). On the other hand, Koch Bihar I (2.10%), Koch Bihar II (1.89%), Mathabhanga I (1.87%), Mekhliganj (1.86%) and Mathabhanga II (0.34%) have positive growth rate of lower than the district average.

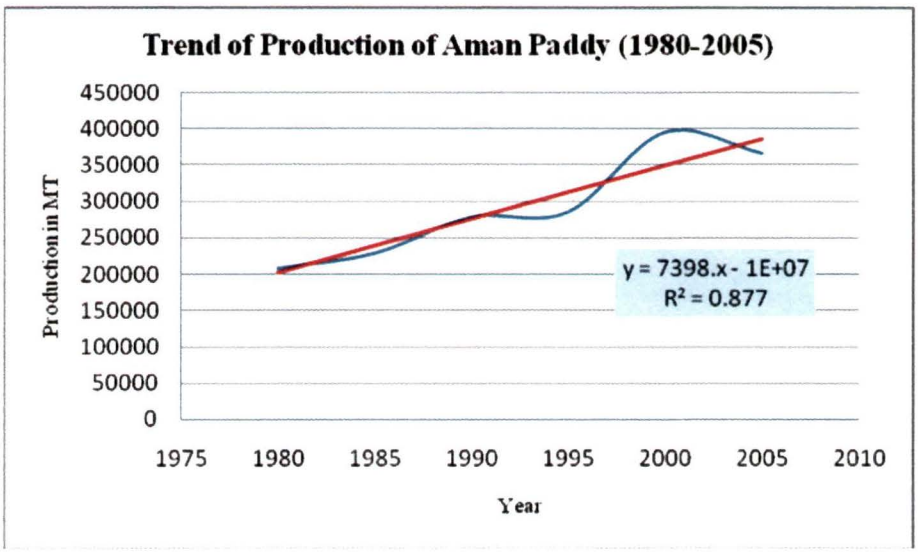


Figure 6.9 Production trends of Aman paddy

6.4.3 *Boro* paddy

In case of *boro* production, the compound growth rate has increased by 24% per annum during the study period in the district as a whole (Fig. 6.10). Trend of increase in all the blocks shows positive compound growth. There is spatial variation at block level in boro

production. This reveals that the highest growth rate is observed in Dinhata II (27%) while the lowest growth rate is found in Haldibari (7%).Three blocks of the district namely Tufanganj II (26%), Koch Bihar I (25%), have shown higher growth rates than the district average. On the other hand, five blocks namely Tufanganj I (22%), Dinhata I (21%), and Mathabhanga I (21%) and Koch Bihar II (19%) have increased in production with growth rates lower than the district average. The compound growth rates of the rest of four blocks could not calculated due to non-availability of data for the year 1980-81.

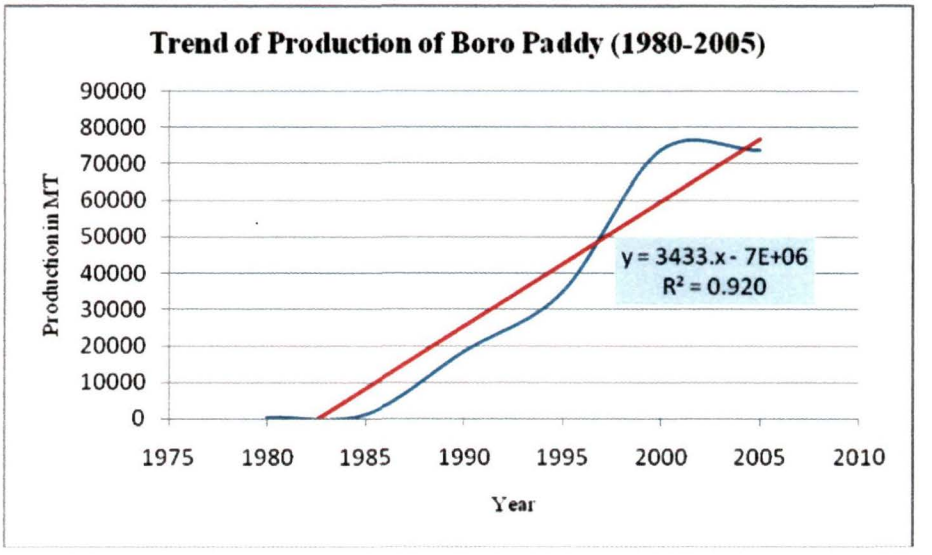


Figure 6.10 Production trends of Boro paddy

The compound growth rates of production of important crop groups in different blocks show that cereals record an increase of 2.14% per annum at district level. The spatial variations at block levels have observed during the study period. The Dinhata II block has shown the highest increase (3.96%) in this regard. The lowest positive compound growth rate has observed in Haldibari block (1.24%). The other blocks showing higher growth rates than district's averages are Tufanganj II, Tufanganj I, Koch Bihar I, Mekhliganj, Sitalkuchi while the blocks show positive growth rate with lower than the district averages are Mathabhanga I, Koch Bihar I, Dinhata I and Sitai. This may be due to that more emphasis has given on inputs like HYVs seeds, supply of water through irrigation, use of chemical fertilisers. Some blocks have observed a negative growth rate that may be mainly because of lack of irrigation and non-availability of credit facilities of the farmers.

The production of pulses has shown an annual increase of 0.08% for the district whereas such blocks like Sitalkuchi (2.89%), Dinhata I (1.72%), Koch Bihar II (1.67%), Tufanganj II (1.04%), Mekhliganj (0.52%), and Tufanganj I (0.27%), Mathabhanga I (0.16%) have shown growth rates higher than district average. On the other hand, following blocks namely Koch Bihar I (2.88%), Sitai (0.63%), Mathabhanga II (0.17%) and Dinhata II (0.06%) have identified as the negative growth rate. The food grains as well as food crops have shown an increasing trend in almost all the blocks except the block Mathabhanga II (-0.02%) which may be due the following reasons: i) it is being a less profitable crops, ii) farmers disagree to sown these crops due to less production and iii) pulses are interchanged by other crops.

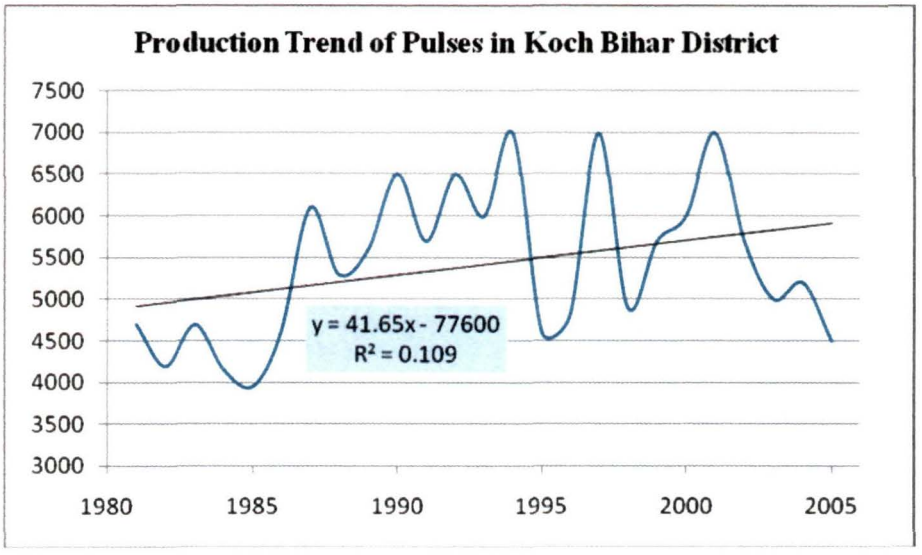


Figure 6.11 Production trends of Pulses

The analysis with regard to production during the study period reveals an encouraging picture and it is expected that this trend would continue in future also (Figure 6.11).

6.4.4 Jute

Jute production in the district has recorded an annual growth rate of 0.58 percent during the study period (Figure 6.12). Out of the twelve blocks of the district, five blocks namely, Koch Bihar I, Sitalkuchi, Haldibari, Mathabhanga II, and Koch Bihar II have increased in production higher than the district average while four blocks namely Mekhliganj,

Dinhata II, Tufanganj I, and Mathabhanga I have increased in production lower than the district average. Only three blocks of the district have shown negative growth rate namely Tufanganj II, Sitai and Dinhata I.

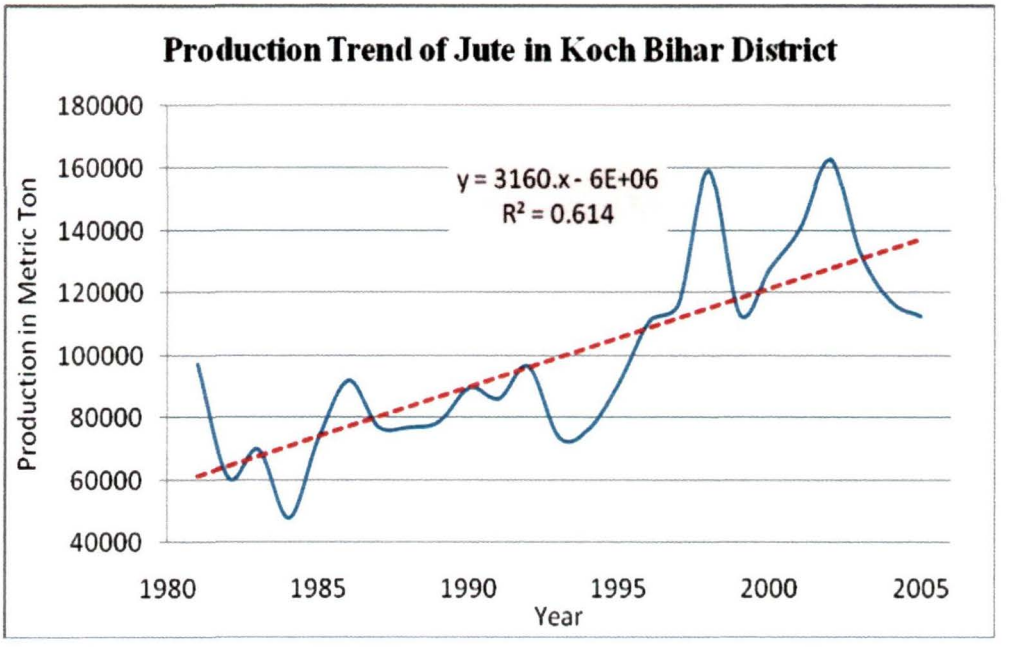


Figure 6.12 Production trend of Jute

6.4.5 Potato

Potato production in the district has significantly increased during the study period at a compound growth rate of 15.58% per annum (Figure 6.13). Production has increased in all the blocks of the district. The spatial variation has also observed at block level in respect of potato production during the study period. The highest increase in growth rate has identified in Koch Bihar II (19.26%) while the lowest growth rate in production has found in Koch Bihar I (4.6%). Mathabhanga II, Mekhliganj, Dinhata II, Dinhata I blocks are identified which have shown higher growth rate in production than the district average. On the other hand, Tufanganj II, Tufanganj I, Mathabhanga I, Sitalkuchi, Haldibari and Koch Bihar I blocks have shown positive growth of lower than the district average. The compound growth for Sitai block could not computed due to the lack of data for the year 1980-81.

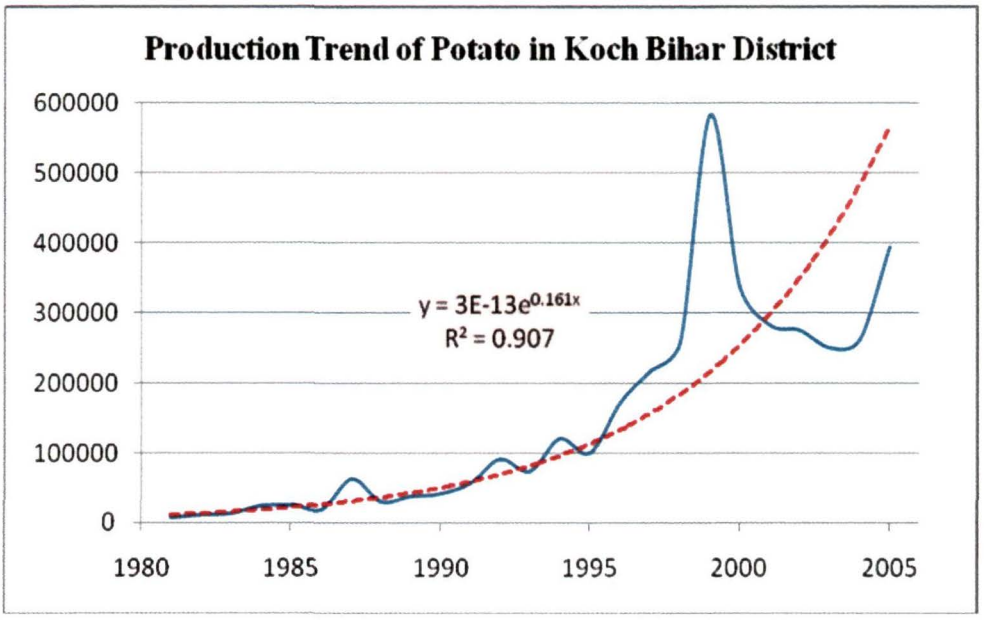


Figure 6.13 Production trend of Potato

6.4.6 Vegetables

Production of green vegetables has increased at the compound growth of 9.05% per annum as a whole in the district. All blocks show growth in terms of production during the study period. The highest compound growth rate has found in Sitai (10.82%) while the lowest increase has found in the Dinhata I (7.56%). Out of the twelve of the district, seven blocks namely Mathabhanga II, Koch Bihar I, Haldibari, Mathabhanga I, Tufanganj II, and Sitalkuchi have increased at the compound growth rates higher than the district average. On the other hand, Tufanganj I, Dinhata II, Koch Bihar II, Mekhliganj and Dinhata I have increased in production lower than the district average.

6.4.7 Spices

In respect of spices production, the district has shown increase of 8.11% per annum during the study period. All blocks of the district have registered growth in spice production. The highest compound growth rate has found in Sitai (14.06%) while the lowest increase has found in the Sitalkuchi (4.46%). Out of the twelve, five blocks have increased in compound growth rate higher than the district average. On the other hand, seven blocks have increased in production lower than the district average.

6.4.8 Tobacco

Tobacco is one of the most important cash crops in the district. The compound growth rate of tobacco production in the district has increased by 1.67% per annum (Figure 6.14). The spatial variation has also observed at block level in respect of potato production during the study period. The highest increase in growth rate has identified in Koch Bihar I (3.83%) while the lowest growth in production has found in Mathabhanga I (0.85%). Out of the twelve, seven blocks have shown growth while only in one block namely Mathabhanga II recorded decline by 5.32% per annum. The rest of the four blocks do not occupy countable area under tobacco cultivation, as a result these four blocks have no significant contribution in the tobacco production in the district.

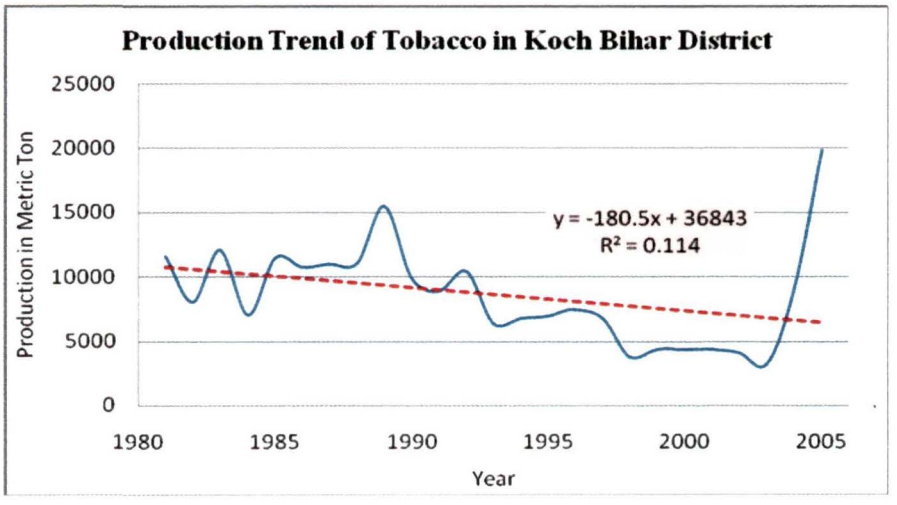


Figure 6.14 Production trend of Tobacco

6.5 Growth trends of productivity

The spatio-temporal variations in the productivity of major crops at block level in the Koch Bihar district has been analysed by calculating the compound growth rates in order to expound the growth trends of cropping pattern. The compound growth rate for the different crops has been calculated by using the following formula:

$$r = [(\sqrt[n]{P_n / P_o}) - 1] * 100 \% \qquad \text{.....6.2}$$

Where, r = Compound growth rate; n = No. of years; P_n = Component per hectare yield rate of the final year and P_o = Component per hectare yield rate of the initial year

Table 6.10
Compound growth of production of principal crops in Koch Bihar district (1980-81 and 2004-2005)

Block	Aus	Aman	Boro	Wheat	Pulses	Oilseeds	Jute	Potato	Vegetables	Tobacco
Mekhliganj	-9.28	1.86	NA	5.35	0.52	6.02	0.39	16.66	7.72	2.30
Haldibari	NA	2.62	7.71	-3.67	-100	NA	1.36	8.41	10.28	-
Mathabhanga I	-1.88	1.87	21.04	1.85	0.16	4.04	0.04	12.76	10.16	0.85
Mathabhanga II	-15.55	0.34	NA	1.37	-0.17	4.99	1.32	17.95	10.65	-5.32
Sitalkuchi	-1.01	2.55	NA	-2.77	2.89	-0.24	1.42	10.84	9.53	1.92
Koch Bihar I	-4.96	2.10	25.46	2.64	-2.88	4.93	1.81	4.60	10.32	3.83
Koch Bihar II	-11.33	1.89	19.16	2.21	1.67	5.81	1.10	19.26	7.84	-
Tufanganj- I	-3.40	2.86	22.70	2.83	0.27	3.03	0.20	14.11	8.24	-
Tufanganj- II	-3.58	2.91	26.90	2.51	1.04	4.13	-4.82	14.79	9.74	-
Dinhata I	-22.26	2.31	21.99	1.18	1.72	5.42	-0.01	15.76	7.56	2.06
Dinhata II	-3.30	4.02	27.93	-1.13	-0.06	6.85	0.32	16.41	8.12	1.77
Sitai	-5.69	3.24	NA	1.38	-0.63	-6.51	-0.86	NA	10.82	1.27
Total	-5.46	2.28	24.96	2.06	0.08	5.40	0.58	15.58	9.05	1.67

The growth in yield per hectare is more important than growth in area and production because this is an indicator of the development. Table shows the compound growth rates of production of various crops during the study period for each block and the district. These compound growth rates of productivity (yield rate) have been calculated by using the following formula:

The table No. 6.11 shows the compound growth rates of productivity of 32 crops namely during 1980-81 to 2004-05 for the district and the table 6.12 depicts block wise productivity growth pattern. Spatial distribution of compound growth rates for different crops have shown in figures 6.13a, 6.13b, 6.13c, 6.13d; 6.14a, 6.14b, 6.14c, 6.14d; 6.15a, 6.15b, 6.15c and 6.15d. This helps to identify the spatial pattern as well as variation in level of agricultural productivity in the Koch Bihar district during the study period.

6.5.1 Paddy

Paddy as a whole shows significant growth in yield rate in the district during the period of 25 years. All blocks of the district show growth in terms productivity of paddy in the district. The most spectacular growth has found in Sitai Block (3.06%) while the lowest growth is noticed in Mathabhanga II Block (0.49%). The growth rate in five blocks namely

Sitai, Tufanganj II, Dinhata II, Tufanganj I, Haldibari has been found higher than the district average while the seven blocks namely Mathabhanga II, Koch Bihar I, Dinhata I, Koch Bihar II, Sitalkuchi, Mathabhanga I and Mekhliganj show a growth rate lower than the district average (Figure 6.13d).

Table: 6.11 Yield rate (kg/hectare) of major crops in Koch Bihar district

Sl No	Crops	1980-81	1985-86	1990-91	1995-96	2000-01	2004-05
1	Aus	796	733	1774	1257	1599	1291
2	Aman	1121	1171	1996	1261	1695	1691
3	Boro	3168	2967	3610	2404	2591	2294
4	Paddy	1018	1043	1972	1298	1772	1757
5	Wheat	1582	2050	1645	1685	1981	1900
6	Maize	1680	1518	1240	1177	1875	5036
7	Ragi	-	200	250	300	266	300
8	Small Millets	642	591	746	860	700	720
9	Cereals (total)	1041	1088	1157	1292	1786	1788
10	Masur	327	435	412	358	437	317
11	Maskalai	364	615	542	462	549	625
12	Khesari	433	520	652	883	1074	551
13	Arhar(Tur)	836	429	-	-	668	-
14	Moong	500	414	526	644	380	363
15	Matar	560	392	597	767	827	639
16	Kulti	665	650	763	763	400	620
17	Total Pulses	484	538	607	660	663	562
18	Food grain (total)	1029	1074	1303	1269	1750	1755
19	Rapeseed & Mustard	283	525	511	469	627	397
20	Linseed	258	230	265	291	402	203
21	Til	748	427	504	374	567	619
22	Niger	410	300	610	600	600	710
23	Jute	1289	1152	1393	1363	1676	1710
24	Others fibers	1089	1098	1187	1334	1463	1597
25	Potato	5885	5993	10724	19993	23031	25397
26	Green Vegetables	13780	14120	14610	14540	14980	15123
27	Chilies	1036	543	1085	1069	1079	1660
28	Ginger	2471	2050	2060	2000	2500	2500
29	Turmeric	1050	1000	1025	1500	1500	1500
30	Areca nut	1650	1587	1600	2150	1500	5000
31	Spices	1565	-	-	-	-	2128
32	Tobacco	1006	1075	988	752	500	1378

Source: i) District Statistical Hand Book, Bureau of Applied Economics and Statistics, b. District Agricultural Annual Plan, Office of the Principal Agriculture Officer, Koch Bihar, Govt. of W. B.

6.5.1.1 ***Aus***

Aus paddy shows a marginal increase of 1.95% in the district. The spatial variation at block level has observed. The highest growth has observed in Dinhata II block (2.79%) while the lowest increase observed in the Sitai block (0.77%). There are seven blocks in the district that show the higher growth than that of the district average while five blocks namely Sitai, Tufanganj II, Sitalkuchi, Dinhata I, Koch Bihar I show that lower than the district average (table 6.12 & figure 6.13a).

6.5.1.1 *Aman*

The growth of *aman* paddy productivity has found lower than that of *aus* paddy i.e., 1.66%. The highest growth has found in Sitai (2.87%) while zero growth has found in Mathabhanga II block. Eight out of the twelve blocks in the district recorded a growth more than the district average (table 6.12 & figure 6.13b).

6.5.1.3 *Boro*

Negative growth of *boro* paddy of (-1.28%) has been observed in the district. The spatial variation in growth of *boro* paddy at block level is noticed which indicates that the out of the twelve blocks eleven blocks have registered negative growth and only one block namely Dinhata II shows a marginal positive growth (*Figure 6.13c)*.

6.5.2 Wheat

Productivity of wheat in the district increased at a rate of 0.74% per annum. Nine out of twelve blocks show positive increase while the remaining three blocks namely Sitalkuchi, Dinhata II and Koch Bihar II observed negative growth. Mekhliganj, Sitai, Tufanganj II, Tufanganj I, Haldibari, Mathabhanga I recorded growth more than the district average and the remaining blocks namely Koch Bihar I, Mathabhanga II and Dinhata I recorded a growth less than that of the district's average (figure 6.12 & *figure 6.14a)*.

6.5.3 Jute:

The productivity of jute in the district has found to increase by 1.14% per annum during the study period. All the blocks of the district have shown growth rate except Dinhata

II. The highest growth has identified in Koch Bihar I (1.89%) while the lowest has recorded in Mekhliganj (Figure 6.14b).

Table No. 6.12a

Block-wise compound growth of yield rate (kg/hectare) of major crops in Koch Bihar district

Name of Block	*Aus* Paddy			*Aman* Paddy			*Boro* Paddy		
	80-81	04-05	Growth	80-81	04-05	Growth	80-81	04-05	Growth
Mekhliganj	777	1540	2.77	1120	1693	1.67	-	2134	-
Haldibari	759	1437	2.59	1017	1654	1.96	3125	2539	-0.83
Mathabhanga-I	711	1381	2.69	1168	1801	1.75	3250	1440	-3.20
Mathabhanga-II	753	1278	2.14	1172	1176	0.01	-	2198	-
Sitalkuchi	722	1068	1.58	1004	1599	1.88	-	2031	-
Koch Bihar I	826	1324	1.91	1273	1590	0.89	3000	2937	-0.08
Koch Bihar II	847	1431	2.12	1163	1753	1.65	3071	2238	-1.26
Tufanganj- I	826	1388	2.10	1183	1955	2.03	3400	2079	-1.95
Tufanganj- II	830	1173	1.39	1121	2056	2.46	3091	2208	-1.34
Dinhata I	820	1299	1.86	1121	1603	1.44	3143	2300	-1.24
Dinhata II	811	1612	2.79	978	1853	2.59	3000	3088	0.12
Sitai	783	949	0.77	872	1770	2.87	-	2003	-
Total	796	1291	1.95	1121	1691	1.66	3168	2294	-1.28

Source: i) District Statistical Hand Book, Bureau of Applied Economics and Statistics,; ii) District Agricultural Annual Plan, Office of the Principal Agriculture Officer, Koch Bihar, Govt. of W.B.

6.5.3 Potato

In case of productivity of potato, the study reveals a significant increase in growth rate by 5.83% per annum in the district during 1980-81 to 2004-05. All the blocks have recorded an increased productivity during the study period. The highest growth has identified in Mathabhanga II (9.76% per annum) while the lowest growth has observed in Dinhata II (3.28%). Significant growth has noticed in Haldibari (9.63%), Mathabahanga I (7.43%), Dinhata I (6.44%) and Mekhliganj (6.38%) blocks. Table 6.12 and figure 6.14.d show the growth in productivity of potato in different blocks of Koch Bihar district.

6.5.5 Pulses:

Productivity of pulses in Koch Bihar is declining trend and the compound growth assessed to be -0.26% per annum over the study period. Out of the twelve, seven blocks have registered negative growth namely Koch Bihar I, Mathabhanga II, Dinhata II, Tufanganj II,

Sitalkuchi, Tufanganj I and Koch Bihar II. The remaining blocks have shown growth i.e., Dinhata I, Mekhliganj, Mathabhanga I, Sitai and Haldibari (Figure 6.14c).

Table No. 6.12b
Block-wise compound growth of yield rate (kg/hectare) of major crops in Koch Bihar district

	Wheat			Jute			Pulses		
Name of Blocks	80-81	04-05	Growth	80-81	04-05	Growth	80-81	04-05	Growth
Mekhliganj	1279	2545	2.79	1103	1368	0.86	254.53	629	3.69
Haldibari	1351	1719	0.97	1331	2016	1.67	333.33	450	1.21
Mathabhanga-I	1600	2015	0.93	1307	1710	1.08	250	544	3.16
Mathabhanga-II	1580	1779	0.48	1331	1836	1.29	1203.7	481	-3.60
Sitalkuchi	2786	1809	-1.71	1239	1944	1.82	348.4	192	-2.36
Koch Bihar I	1650	1965	0.70	1230	1962	1.89	1157.14	450	-3.71
Koch Bihar II	1570	1501	-0.18	1255	1818	1.49	562.5	517	-0.34
Tufanganj- I	1624	2079	0.99	1259	1638	1.06	736.11	507	-1.48
Tufanganj- II	1560	2071	1.14	1287	1638	0.97	800	406	-2.68
Dinhata I	1619	1680	0.15	1519	2214	1.52	157.89	569	5.26
Dinhata II	1604	1080	-1.57	1428	990	-1.45	1111.11	516	-3.02
Sitai	1350	2381	2.30	1101	1584	1.47	280	545	2.70
Total	1582	1900	0.74	1289	1710	1.14	599.56	562	-0.26

Source: i) District Statistical Hand Book, Bureau of Applied Economics and Statistics,; ii) District Agricultural Annual Plan, Office of the Principal Agriculture Officer, Koch Bihar, Govt. of W.B.

6.5.5 Oilseeds

The productivity of oilseeds has marginally increased at a compound growth rate of 0.71% per annum as a whole in the district during the study period. Except one namely Mathabhanga I all the blocks have observed positive compound growth. The highest increase has observed in Sitai i.e., 3.85% per annum (Figure 6.15a).

6.5.6 Tobacco

Koch Bihar is one of the most important tobacco growing districts of West Bengal. The district has shown a marginal increase of 1.61% per annum during the study period. The highest growth rate observed in Koch Bihar I (4.07%) while the lowest increase found in Sitai (0.64%). Other blocks showing higher rates of growth than the district's average are Mekhliganaj, Dinhata I, Mathabhanga II and the blocks showing lower rates of growth than the district averages are Sitalkuchi, Dinhata II, Mathabhanga I and Sitai. Compound growth rate of four blocks namely Haldibari, Koch Bihar II, Tufanganj I and Tufanganj II could not be calculated due non-availability of data (Figure 6.15b).

Table No. 6.12c

Block-wise compound growth of yield rate (kg/hectare) of major crops in Koch Bihar district

Name of Blocks	Potato			Oilseeds			Green Vegetables		
	80-81	04-05	Growth	80-81	04-05	Growth	80-81	04-05	Growth
Mekhliganj	5000	23460	6.38	362	859	3.52	13512	15122.56	0.45
Haldibari	2325	23141	9.63	282	340	0.75	15200	22135.54	1.51
Mathabhanga-I	4000	23980	7.43	420	410	-0.10	10080	14004.39	1.32
Mathabhanga-II	2714	27851	9.76	286	570	2.80	11000	13942.48	0.95
Sitalkuchi	5533	18247	4.89	462	802	2.23	10250	12798.13	0.89
Koch Bihar I	6250	24145	5.55	371	715	2.66	12300	15209.59	0.85
Koch Bihar II	12400	25491	2.92	415	420	0.05	15400	13979.21	-0.39
Tufanganj- I	10778	27303	3.79	333	530	1.88	15300	14421.84	-0.24
Tufanganj- II	9167	24702	4.04	607	626	0.12	14200	15257.42	0.29
Dinhata I	6433	30623	6.44	418	782	2.54	16100	13970.87	-0.57
Dinhata II	9375	21009	3.28	339	750	3.23	15500	14505.09	-0.27
Sitai	NA	13097	-	350	900	3.85	11612	17096.55	1.56
Total	6165	25397	5.83	374	446	0.71	13781	14988.92	0.34

Source: i) District Statistical Hand Book, Bureau of Applied Economics and Statistics, ii) District Agricultural Annual Plan, Office of the Principal Agriculture Officer, Koch Bihar, Govt. of W.B.

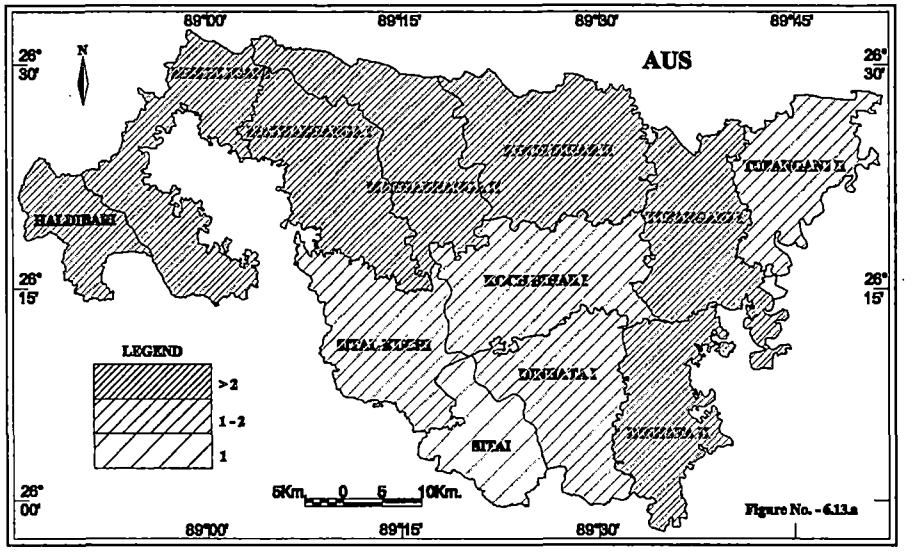
6.5.7 Vegetables

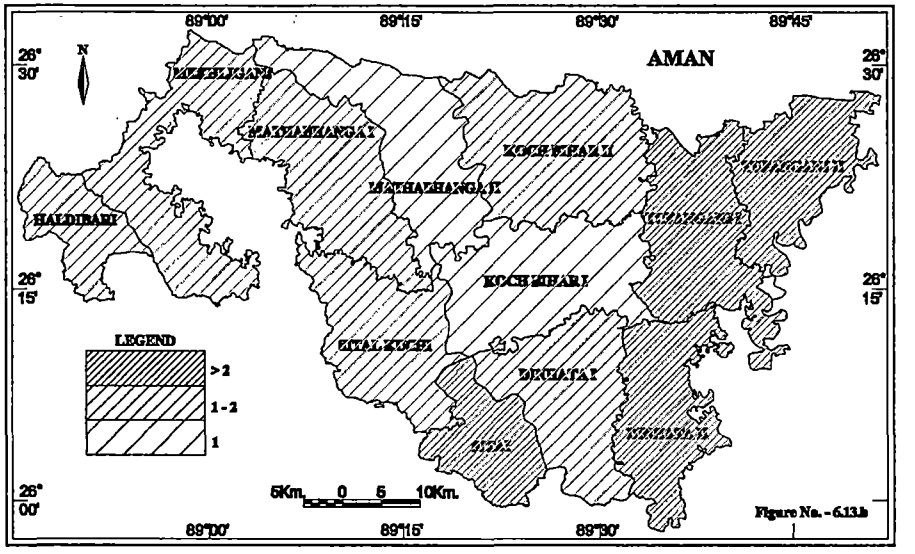
The productivity of green vegetables in the district has been found increased by 0.34% per annum as a whole in the district during the study period. Significant increase has recorded in Sitai (1.56%), Haldibari (1.51%) and Mathabhnaga I (1.32%); moderate increase found in Mathabhanga II, Sitalkuchi, Koch Bihar I and low increase found in Mekhliganj and Tufanganj II. Negative growth has recorded in Dinhata I, Koch Bihar II, Dinhata I & II and in Tufanganj I blocks during the study period (Figure 6.15c).

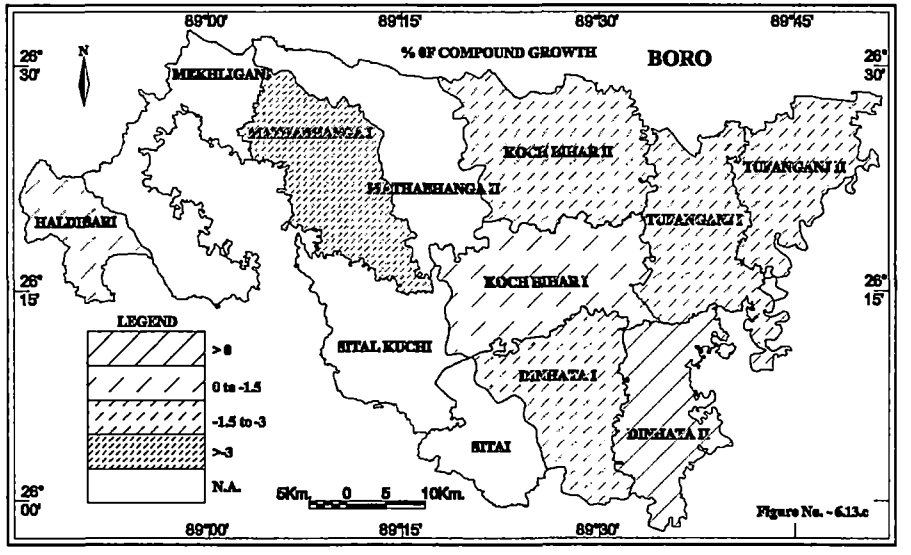
6.5.8 Spices

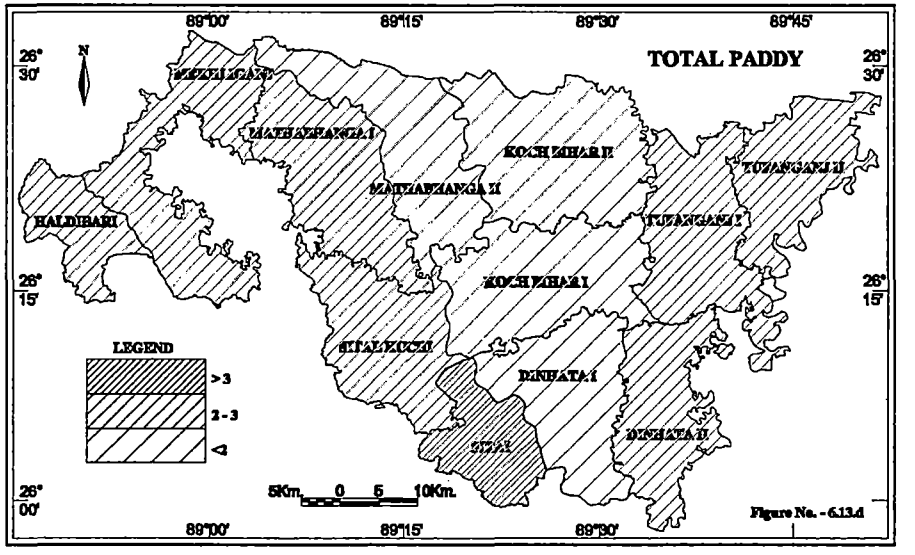
Koch Bihar has been showing significant increase in the cultivation of spices recently. The district has shown a marginal increase in respect of productivity of compound growth rates accounting for 1.24% per annum. All the blocks have shown the positive compound growth rates during the study period. The highest growth has identified in Haldibari (1.89%) while the lowest growth has found in Dinhata I (0.73%) (Figure 6.15d).

COMPOUND GROWTH (IN %) OF YIELD RATE OF MAJOR CROPS IN KOOCH BIHAR DISTRICT









COMPOUND GROWTH (IN %) OF YIELD RATE OF MAJOR CROPS IN KOOCH BIHAR DISTRICT

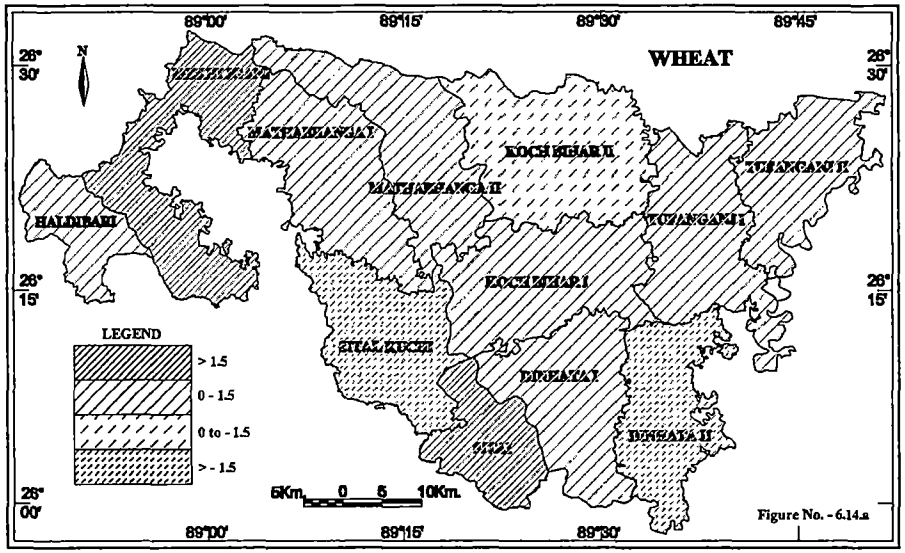
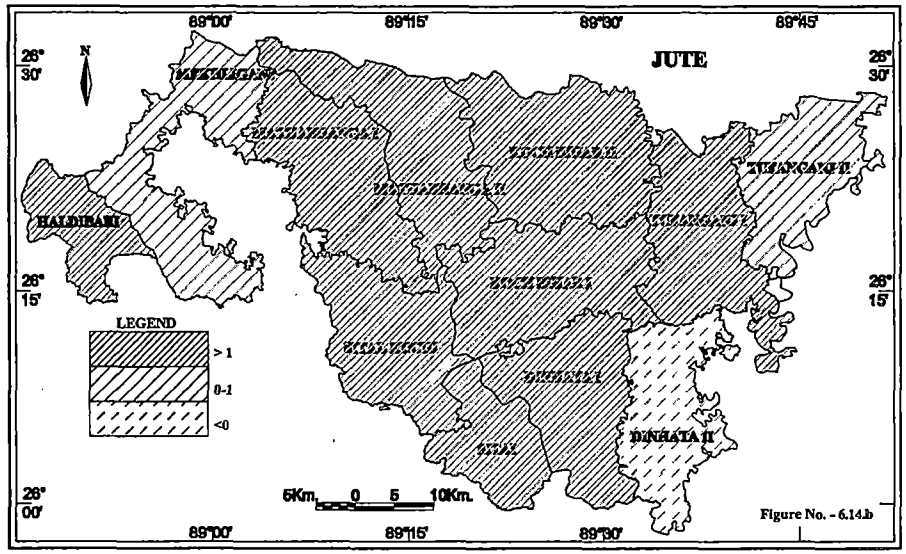


Figure No. - 6.14.a



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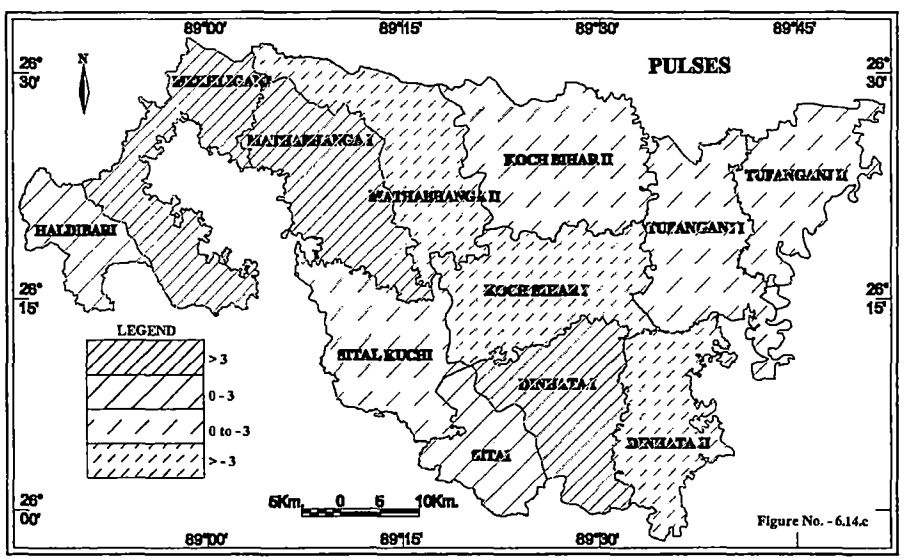

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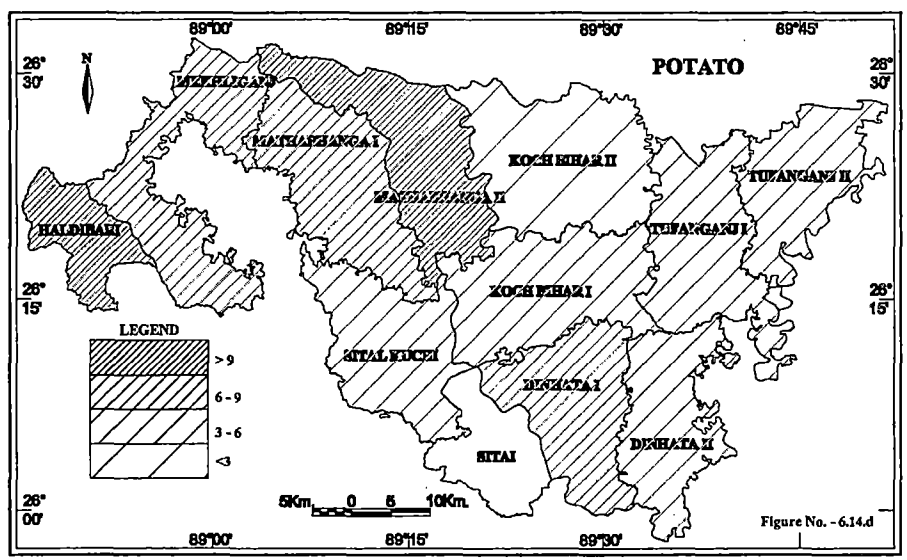
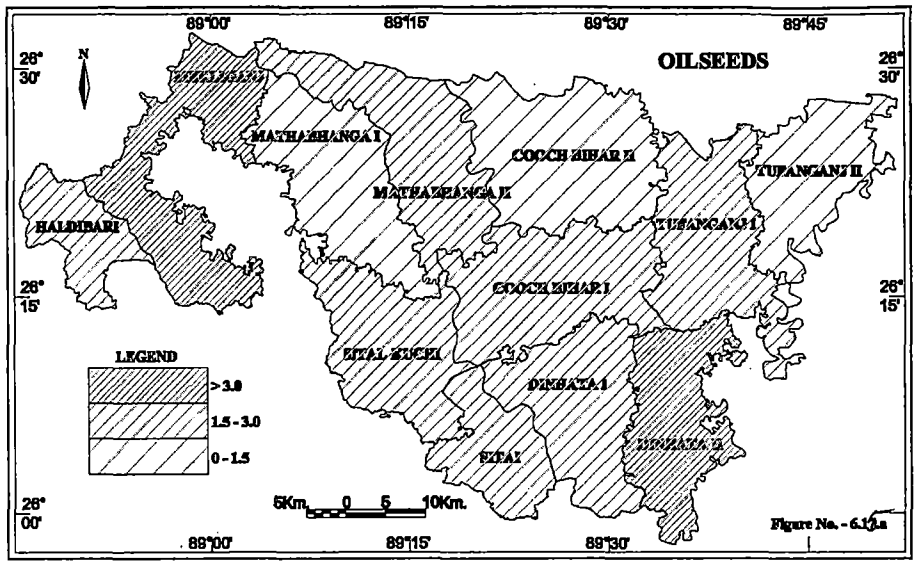
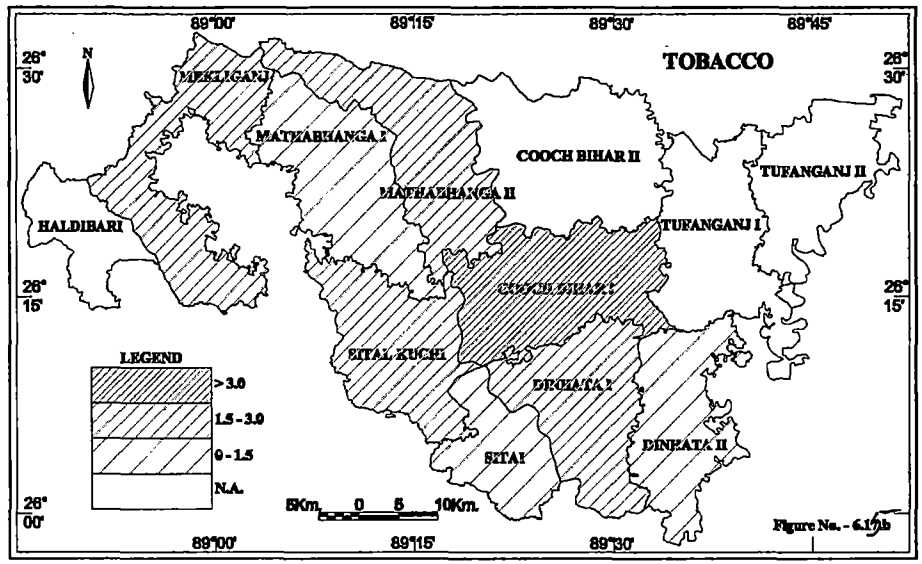
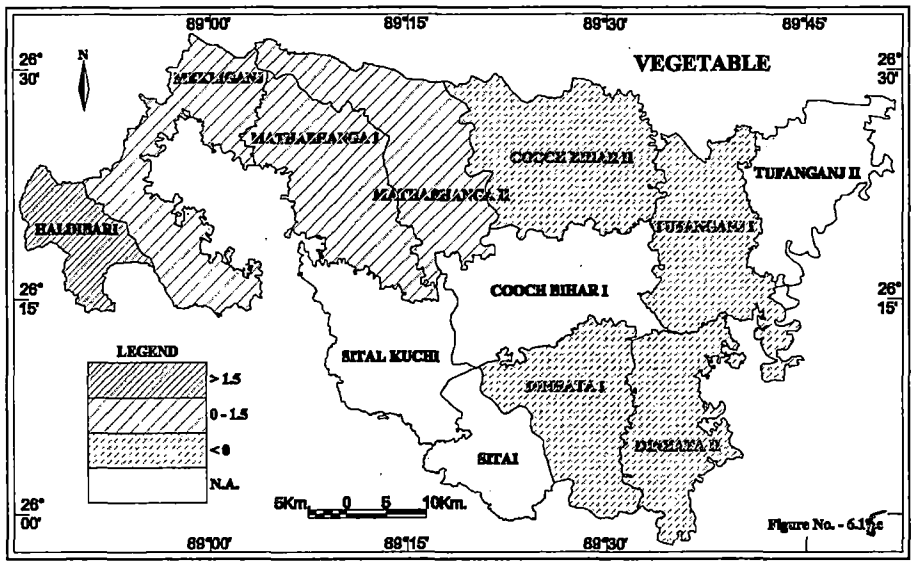


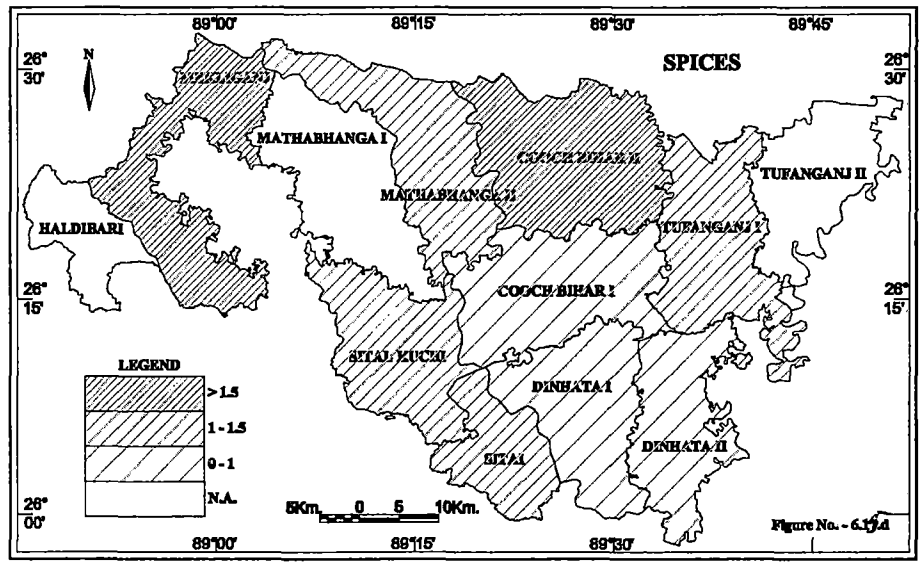
Figure No. - 6.14.d

COMPOUND GROWTH (IN %) OF MAJOR CROPS IN KOOCH BIHAR DISTRICT









6.6 Conclusion

Crop concentration and yield indices (CYCI) present a vivid picture of the level of agricultural productivity of Koch Bihar district for the year 2004-05. In this method, higher the index value, lower the efficiency and vice-versa. The study based on this method reveals that the first ranking crops in the district are paddy in Mathabhanga II (91.3), wheat in Haldibari (54.5), jute in Tufanganj II (61.11), potato in Sitai (38.2), green vegetables in Sitalkuchi (75.35), pulses in Dinhata I (50.8), oilseeds in Haldibari (58.27), tobacco in Mathabhanga II (52.92). The least efficient block in terms of CYCI are Tufanganj II in paddy (130.3), Mekhliganj in wheat (185.3), Haldibari in Jute (134.4), Koch Bihar II in potato (161.6), Haldibari in vegetables (151.1), Mathabhanga I in pulses (170.9) and Sitai in tobacco (414.2).

A comparative analysis of agricultural efficiency by applying Bhatia's method for both the periods (1980-81 and 2004-05) in Koch Bihar district has revealed that the most efficient block in terms of productivity is Koch Bihar I (105.53) in 1980-81 and Haldibari (112.01) in 2004-05. Mean and standard deviations of the agricultural efficiency were 96.94 and 2.53 respectively in 1980-81 whereas in 2004-05 these values are 102.71 and 1.05. On the other hand, co-efficient of variation of agricultural efficiency is lower (1.02 %) in 2004-05 than that of 1980-81 (2.61%). This indicates that the consistency of agricultural efficiency is higher in 2004-05 than that of 1980-81.

The level of agricultural productivity for crop groups like cereals, pulses, oilseeds and cash crops in the Koch Bihar district by applying the technique of productivity per unit area (P/A Ratio), it is observed that first ranking efficient blocks are Koch Bihar I for cereals (1033.9) and pulses (15.22), Tufanganj II for oilseeds (18.24), Dinhata I for cash crops (12036) in 1980-81 whereas in 2004-05 the above mentioned blocks replaced by Haldibari for cereals (259.96), Mekhliganj for pulses (2.19), Mathabhanga II (for oilseeds (96.0) and Dinhata I for cash crops (260.98). The least efficient blocks for the both periods are Mathabhanga II (27.03) and Koch Bihar II (-337.13) for cereals, Mathabhanga I (-8.86) and Tufanganj II (-17.12) for pulses, Haldibari (-13.68) and Koch Bihar I (-49.13) for oilseeds and Tufanganj I (-138.76) and Mekhliganj (-253.8) for cash crops.

The above study reveals that during the study period, there is a spatio-temporal variation in agricultural efficiency in the district. The study period shows that out of 12 blocks, 11 blocks identified where agricultural efficiency for twenty major crops has increased considerably. The Haldibari block registered the highest increase and Mathabhanga I observed the lowest increase during the study period. Only one block namely Mathabhanga II in the district showed the decline in agricultural efficiency.

Further, compound growth rates of various crops in terms of gross production are analysed as a whole of the district as well as block wise spatial change. Annual gross production of *aus* paddy has declined by 5.46% whereas *aman* and *boro* paddy production has increased by 2.28% and 20% respectively. It has also noticed that cereals production has increased by 2.14% per annum. The co-efficient of co-relation (r= 0.71) is very high for paddy. The production of pulses shows very nominal increase of 0.08% with 'r' value is 0.11. This result indicates that pulses are non-profitable crops in the district. Jute production has increased at the rate of 0.58% annually and its 'r' value is 0.61 that shows high increasing trend of jute production. An excellent growth of potato production in the district has noticed. The annual compound growth rate is 15.58% and the corresponding 'r' value is 0.91. It proves that the growth rate of potato production during the study period is very high. Production vegetables and spices have also increased at the rate of 9.05% and 8.11% respectively during the study period. A declining trend of 'r' value 0.11 of tobacco is observed in the district though the annual growth of production of tobacco is positive i.e. 1.67%.

The compound growth rate in terms of yield rate (KG/Per Hectare) during the study period has been calculated and analysed. The yield rates of *aus*, *aman*, *boro* paddy are 1.95%, 1.66% and -1.28% respectively. The law of diminishing returns of productivity of land is the main cause of negative growth of *boro* paddy. Wheat, jute, potato, oilseeds, tobacco, green vegetables and spices show the growth of yield rate and their respective growth rates are 0.74%, 1.14%, 5.83%, 1.61%, 0.07%, 0.34% and 1.24% respectively. A declining compound growth rate (-0.36%) is observed in the yield rate of pulses.

6.7 References

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