

CHAPTER VII

7.0 AGRICULTURAL REGIONS IN KOCH BIHAR DISTRICT

7.1. Introduction

Agricultural regions are those, which are divided the agricultural area into different homogeneous units. Different geographers have defined agricultural region. Buchanan R. (1959) defined *it is an area of homogeneous agricultural character*. Grigg D. (1969) has defined as *many farms with fair likeliness can be grouped together as type of agriculture, when similar types predominate in one area and that area can be described as an agricultural region*. Morgan and Munton (1971) described it as a *convenient way of dividing and classifying area in order to create a simplified picture of the spatial pattern of agricultural activities*. According to Losch (1954), *it as different names such as belt, zone, region, or even economic landscape*. Thus, an area with uniformity in landscape, farming methods and associated agricultural features is called an agricultural region.

The above definitions of agricultural region are traditional one though it does not lose its significance. For the sake of agricultural regionalization, various elements have been taken into consideration. Agro-climatic regions are determined based on climate. Extensive and intensive agricultural regions are classified based on land available for cultivation. In Netherlands, it is similar to soil region. In past the delineation of agricultural region is mostly dealt on natural criterion.

The main characteristics of agricultural regions are; i) they have distinctive location, ii) they have transitional boundaries, iii) they may be either formal or functional and iv) they may be hierarchically arranged. Different scholars of agricultural geography such as D. Whittlesey (1936), J. Kostrowicki (1964), N. Helburn (1957), K. Kawachi (1959), D. Grigg (1969) have either attempted for regionalization on some criteria or based on quantitative techniques.

7.1.1 Bases of agricultural regions

The bases of agricultural regions are: i) combination of crops and livestock, ii) the levels of agricultural productivity, iii) agricultural intensity, iv) degree of commercialization, v) degree of subsistence level, vi) types of farming practices, vii) availability of infrastructure and diffusion of farm technology and viii) statistical and quantitative measure.

7.1.2 Technique of delineating agricultural region

According to J. Singh (1984) *technique is taken to be an actual way of handling a body of data with a battery of statistical tools for accomplishing something or for solving some problems.* The main techniques used by geographers of delineating Agricultural regions are: a) Normative technique, b) Empirical technique, c) Single element technique, d) Multi-element technique, e) Statistical technique and f) Multifaceted technique.

a) The Normative Technique

Von Thunen's model (1826) of agricultural region based on normative technique where various assumptions such as flat plain surface of uniform fertility, equal transport facility, only one market, only one crop is cultivated, inverse relation between intensity of cropping and distance from the market and economic rent etc. have been taken into consideration. Hence, Von Thunen's model is more theoretical it is based on some pre-determined conditions (Assumptions) of isolated states E.M. Hoover (1937), A. Losch (1954), E.S. Dunn (1954) and W. Isard (1956) have much influenced by Von Thunen's model for determination of location of economic activities.

b) Empirical Technique

This technique largely based on observed facts and experiments of farmers. O.E. Baker (1925, 1926-1933) in his paper of "Agricultural Regions of North America" first used this method to demarcate the agricultural region. The Cotton belt, the Corn belt and the Wheat belt of USA was determined on the basis of observed data. This technique was used in the early part of the 20th century. O. Jonasson (1925-26), G.E. Jones (1928 & 1930), G. Taylor (1930), S. van. Valkenburg (1931 and 1936), G.B. Cressey (1934), R.B Hall (1934-35) and H.L. Shantz (1940-43) were the pioneer contributors who attempted to classify agricultural regions in the various parts of the world.

c) Single element technique

This is a crude and subjective technique in which the single element of agricultural landscape is taken into consideration. On the basis of degree of concentration and livestock enterprises H.F. Gregor (1970), W.B. Morgan and R.J. Munton (1971) determined the agricultural regions. D. Whittlesy (1936) delineated on the basis of his five grade criteria such as crop and livestock association, method of production, intensity of land use disposal of products and ensemble of structures for the farming operations world into 11 cropping regions. Demarcations of crop ranking regions in India as well as the present study in Koch Bihar district are single element technique i.e. first ranking region, second ranking region etc.

d) The Multi-element technique

The multi-element technique or statistical technique is modification of empirical and single element technique of agricultural regionalization. J.C. Weaver's (1954) Crop Combinational technique K. Doi's (1959) Combinational analysis, J.T. Coppock's Combinational analysis are the examples of this statistical technique. Its main advantage is that it is free from biasness as it is based on statistical data and suitably can be used for agricultural Planning of a particular region.

e) Statistical technique

It is a modification of statistical technique and is based on cluster analysis and combinational analysis (J. Singh, 1980). The method employs firstly, the division of enumeration units into N objects in K groups and each of them are represented as a cluster. Secondly, combination of crops, livestock or agricultural enterprise is included in each cluster.

f) Multifaceted technique

For delimitation of agricultural regions, various elements such as physical (relief, slope, temperature, rainfall, soil etc.), social (land tenancy, size of holding, religion, custom etc.) and economic factors (capital investment, marketing, storage etc.) are taken in to consideration. These techniques are known as quantitative and qualitative techniques of agricultural regionalization. The following fourteen elements which have been categorized:

Group A: Physical (relief, climate, water, soil, subsoil and natural vegetation).

Group B: Cultural vegetation and cultural structures

Group C: Functional (rural population, cultural and technological stage, farming operation, organisation for providing the rural population with economic and cultural goods and commerce.

O. E. Baker (1926), D. Whitlessy (1936), H. Carol (1952) applied this technique for agricultural regionalization. As a result, three categories of agricultural regions namely macro, meso and micro regions are identified. In the present study the Single element approach (crop ranking regions) and Statistical technique (crop combinational analysis and crop diversification regions) have applied for the identification of agricultural regions.

7.2 Crop Ranking Regions

Crop ranking helps for understanding the geographical character of the area. This has been examined by ranking the principal crops of the region according to the relative significance of each crop. Ranking of crops indicates the nature of economy i.e. whether the farmers of a particular areal unit are intensive subsistent farmers, commercial, market oriented or partly intensive subsistence and partly commercial. By determining the relative strength of different crops in a geographical unit, the process of planning can be more rationally adopted for the optimal use of the available land for cultivation. The ranking of crops of the district have been studied for the two periods: (i) the period I (1980-81) and the period II (2004-05). The time series analysis has been attempted for identifying the relative significance of individual crop in cropping pattern for nine principal crops.

7.2.1 Methodology

The ranking regions of different crops have been calculated by considering the relative strength of percentage share to GCA of the block for each crop. The percentage share to GCA of the block for each crop has been considered up to one percent i.e. that is to say, percentage share of crop <1% was not taken in to consideration.

7.2.2 Period I: (1980-81)

7.2.2.1 First Ranking

Only one crop namely paddy occupied the first rank in the district. This crop occupied highest coverage and cultivated in all the blocks of the district for both period. Hence, during the study period of 25 years there is no change in the first ranking crop. Paddy still occupies the dominant a real strength in the cropping pattern of the district.

7.2.2.2 Second Ranking

There were two crops, which occupied second ranking in the period I, namely jute and tobacco while this number increased to three for the period II namely jute, tobacco and green vegetables. Jute was the second dominant crop for the both periods. It was the second dominant crop in eleven blocks and occupied an area of about 380588 hectares (94.96% to GCA) in the district. On the other hand, the relative significance of jute as second ranking crop has declined from eleven blocks to eight blocks that occupying 70.60% to GCA).

Table: 7.1

Block-wise area (hectare) under principal crops and percentage share to GCA (1980-81)

Block	Paddy	Wheat	Jute	Oil Seeds	Pulses	Potato	Vegetables	Spices	Tobacco	Total
Mekhliganj	17150	1610	5670	800	695	190	420	80	1900	28515
Haldibari	14310	490	4940	1100	617.25	80	480	150	160	22327
Mathabhanga-I	26932	920	6335	500	935	160	570	175	1400	37977
Mathabhanga-II	28400	1450	8705	700	548.3	290	500	145	450	41288
Sitalkuchi	20300	420	5045	400	490.15	100	265	170	2100	29290
Koch Bihar I	27541	1350	9210	1400	1038.18	170	565	110	1260	42694
Koch Bihar II	32124	1420	7260	1000	715.12	200	740	190	250	43939
Tufanganj- I	26122	1250	6725	2100	549.22	130	650	170	90	37846
Tufanganj- II	18971	770	5640	700	940.3	120	560	155	30	27886
Dinhata I	25604	1050	6280	610	557.1	280	770	195	2000	37386
Dinhata II	21397	1440	6030	560	552.25	80	640	140	560	31439
Sitai	13940	500	3560	200	462.13	0	150	20	3900	22742
Total	272791	12670	75400	10070	8100	1800	6310	1700	14100	403330

7.2.2.3 Third Ranking

Third ranking crops are widespread and cover a small area as they are distributed in eleven blocks. Five crops namely wheat, jute, oilseeds, pulses and tobacco have been identified as third ranking in the district. Tobacco is the most dominant crop occupied largest coverage of 33.02% of the gross cropped area in four blocks in the district during 1980-81.

Wheat occupied third rank and covering 28.93% of the gross cropped area in three blocks of the district. Oilseeds also ranked third in the cropping pattern during 1980-81 occupied 25.51% of the gross cropped area extending over in three blocks. Jute ranks third position only in one block. Hence the dominance of jute as third rank was replaced by other crops during this period. Pulses was the another group of crops which occupied third rank in one block of the district that covered 6.91% of the gross cropped area.

7.2.2.4 Fourth Ranking

Four crops namely wheat, oilseeds, pulses and green vegetables ranked fourth in the cropping pattern of district during 1980-81. Wheat was the dominant fourth ranking crop in the district which covered 48.86% of the gross cropped area in six blocks. Pulses identified as the second important fourth ranking crop covered 22.21% of the gross cropped area extending in three blocks. Oilseeds has been identified as third significant fourth ranking crops in the district covering 21.13% of the gross cropped area in two blocks. Green vegetables identified as the least significant fourth ranking crop which occupied 7.79% of the gross cropped area only of one block.

Table No. 7.2 Crop Ranking Regions: 1980-81 (Period I)

Sl No	Crops	Crop ranks and number of blocks					
		I	II	III	IV	V	VI
1	Paddy	12	-	-	-	-	-
2	Wheat	-	-	3	6	3	-
3	Jute	-	11	1	-	-	-
4	Oilseeds	-	-	3	2	3	3
5	Pulses	-	-	1	3	2	4
6	Green Vegetables	-	-	-	1	3	4
7	Tobacco	-	1	4	-	1	1
Total		12	12	12	12	12	12

7.2.2.5 Fifth Ranking

Fifth ranking crops showed much varied distribution pattern and involved more number of crops under this rank. There were five crops namely wheat, oilseeds, pulses, green vegetables and tobacco. Green vegetables, wheat and oilseeds were the dominant fifth ranking crops in the district during the period 1980-81 which covered 29.55%, 22.21% and

21.78% of the GCA respectively and each consisting of three blocks. Pulses were the second important fifth ranking crop which shared 15.88% of the GCA consisting of two blocks. Tobacco ranked the least important fifth ranking crop which comprised of 10.59% of the total GCA extending only in one block.

Table 7.3 Ranking of crops, area coverage and distribution in Koch Bihar (1980-81)

Crops	No of Blocks	Blocks in %	Area in hectare	Area in %
<i>FIRST RANKING</i>				
Paddy	12	100	403330	100
<i>SECOND RANKING</i>				
Jute	11	91.67	380588	94.36
Tobacco	1	8.33	22742	5.64
<i>THIRD RANKING</i>				
Wheat	3	25	116666	28.93
Jute	1	8.33	22742	5.64
Oilseeds	3	25	102907	25.51
Pulses	1	8.33	27886	6.91
Tobacco	4	33.34	133168	33.02
<i>FOURTH RANKING</i>				
Wheat	6	50	197069	48.86
Oilseeds	2	16.67	85227	21.13
Pulses	3	25	89594	22.21
Vegetables	1	8.33	31439	7.79
<i>FIFTH RANKING</i>				
Wheat	3	25.00	89594	22.21
Oilseeds	3	25.00	87840	21.78
Pulses	2	16.67	64030	15.88
Vegetables	3	25.00	119171	29.55
Tobacco	1	8.33	42694	10.59
<i>SIXTH RANKING</i>				
Oilseeds	3	25.00	89418	22.17
Pulses	4	33.33	152944	37.94
Vegetables	4	33.33	129478	32.10
Tobacco	1	8.33	31439	7.79

7.2.2.6 Sixth Ranking

There were four crops identified as sixth ranking crop in the district for the period I. These crops were namely pulses, vegetables, oilseeds and tobacco. Pulses and vegetables were the dominant sixth ranking crops which occupied 37.94% and 32.10% of the total GCA, each spreading in four blocks respectively. Oilseed was the next dominant sixth ranking crop which covered 22.17% of the total area under GCA spreading in three blocks. Another sixth

ranking crop was the tobacco which comprised of 7.79% of total area of GCA) consisting of one block.

7.2.3 Period II (2004-05):

7.2.3.1 First Ranking

Paddy occupies the dominant a real strength in the cropping pattern of the district. This crop spreads in all the blocks of the district consisting of cent percent to total GCA.

Table: 7.4 Block-wise areas (hectare) under principal crops and % share to GCA(2004-05)

Block	Paddy	Wheat	Jute	Potato	Pulses	Oilseeds	Tobacco	Vegetables	Spices	Total
Mekhliganj	17900	2980	5020	2370	350	1455	1800	2407	498	34780
Haldibari	11340	150	4560	220	160	510	-	3807	1509	22256
Mathabhanga-I	26800	1160	4880	670	1260	2160	1439	5012	734	44115
Mathabhanga-II	22850	1810	8750	2560	770	1920	75	5442	774	44951
Sitalkuchi	22300	320	4560	380	330	970	2286	2457	393	33996
Koch Bihar I	31150	2170	9030	1520	1435	3730	1240	5797	793	56865
Koch Bihar II	27220	2560	6620	3970	600	3980	-	5677	754	51381
Tufanganj- I	28930	1960	5470	1090	495	4830	-	5457	774	49006
Tufanganj- II	20230	1080	1290	1030	1175	5060	-	5322	763	35950
Dinhata I	22230	1360	4290	1810	530	2890	2100	5767	644	41621
Dinhata II	26980	1620	9400	1040	476	3050	625	5112	733	49036
Sitai	11390	400	1990	180	380	136	4550	1419	403	20848
Total	269320	17570	65860	16840	7961	30691	14115	53679	8772	484808

7.2.3.2 Second Ranking

Three crops namely jute, green vegetables and tobacco occupied the second position in terms of areal strengths during the period II. Jute still occupies the dominant second ranking crop which accounts for 70.60% to GCA consisting of eight blocks district. It was observed that the relative significance of jute as second ranking crop has declined from eleven blocks to eight blocks during the study period. Green vegetables identifies as the next significant second ranking crop in the district. It occupies 25.10% to GCA comprising of three blocks. Tobacco identifies as another second ranking crop which covers only 4.3% of the GCA comprising only one block.

7.2.3.3 Third Ranking

Four crops have been identified as the third ranking crops during 2004-05 namely wheat, jute, oilseeds, and vegetables. Among them vegetables is the dominant crop occupied largest areal coverage i.e., 63.43% to gross cropped area in seven blocks. Jute occupies third rank and comprises three blocks covering 21.98% of the gross cropped area. Oilseeds and wheat rank third in the cropping pattern during the period the period occupied 7.42% and 7.17% area of the gross cropped area respectively and extending over only one block each.

7.2.3.4 Fourth Ranking

The numbers of crops in fourth rank has been identified to be six and are spread over throughout the district. The crop distributional pattern in this ranking has been found fragmented and diversified. Oilseeds rank the dominant position in fourth ranking crops which covered 60.23% of the total GCA spreading over six blocks. Green vegetables identified as the second important fourth ranking crop in the district during the period II which accounts for 11.47% of the total GCA consisting of two blocks. Four crops namely potato, jute, tobacco, and spices which identified as the less significant and more diversified fourth ranking crops in the district during 2004-05.

7.2.3.5 Fifth Ranking:

Six crops have been identified to be fifth rank and show widespread distribution both in space and the number of crops involved. These crops are namely wheat, potato, oilseeds, tobacco, pulses, and spices. Wheat is the most dominant second ranking crop in the district which occupies an area of 31.95% of the GCA in three blocks. Oilseeds is second important fifth ranking crops which shares 20.87% of the total GCA in three blocks. Potato comes to next in the fifth ranking crops which covers 17.77% of the total GCA extending over two blocks. Tobacco identifies as the fourth in fifth ranking crops of the district which covers 17.68% of the GCA spreading over two blocks. While pulses and spices are identified as the least important fifth ranking crops which individually occupies 7.43% and 4.30% respectively of the total GCA.

Table 7.5 Crop ranking regions: 2004-05 (Period II)

Sl No	Crops	Crop ranks and Number of Blocks						
		I	II	III	IV	V	VI	VII
1	Paddy	12	-	-	-	-	-	-
2	Wheat	-	-	1	-	3	4	2
3	Jute	-	8	3	1	-	-	-
4	Oilseeds	-	-	1	6	3	-	1
5	Pulses	-	-	-	-	1	1	3
6	Potato	-	-	-	1	2	5	2
7	Tobacco	-	1	-	1	2	1	-
8	Vegetables		3	7	2	-	-	-
9	Condiments		-	-	1	1	1	4

7.2.3.6 Sixth Ranking

Five crops namely potato, wheat, pulses, tobacco, and spices have been identified as the sixth ranking crops of the district. Potato has been identified as the most significant of sixth ranking crops which covers 45.13% of the total GCA) consisting of five blocks. Wheat is the next which shares 31.59% of the total GCA comprising of four blocks of the district. The remaining three crops namely pulses, tobacco and spices occupy varying proportion of area i.e., 9.10%, 7.17% and 7.01% respectively of the total area of GCA respectively and each of them comprising only one block.

7.2.3.7 Seventh Ranking

Five crops namely spices, pulses, wheat, potato and oilseeds have been identified as the seventh ranking crops of the district. Spices are the most efficient seventh ranking crops covering 40.09% to GCA and consist of four blocks of the district. On the other hand, pulses are next important crop of seventh ranking crops covering three blocks of the district with percentage of areal coverage of 20.62% to GCA. The remaining three crops namely wheat(two blocks), potato (two blocks)and oilseeds (one block) occupy varying proportion of area i.e. 17.68%, 14.44% and 7.17% respectively.

Table 7.6 Ranking of crops, area coverage and distribution in Koch Bihar (2004-05)

Crops	No of blocks	Blocks in %	Area in hectare	Area in %
<i>FIRST RANKING</i>				
Paddy	12	100	484808	100
<i>SECOND RANKING</i>				
Jute	8	66.67	342274	70.60
Tobacco	1	8.33	20848	4.3
Vegetables	3	25.00	121686	25.10
<i>THIRD RANKING</i>				
Wheat	1	8.33	34780	7.17
Jute	3	25	106584	21.98
Oilseeds	1	8.33	35950	7.42
Vegetables	7	58.34	307494	63.43
<i>FOURTH RANKING</i>				
Jute	1	8.33	35950	7.42
Potato	1	8.33	44951	9.27
Oilseeds	6	50	292024	60.23
Tobacco	1	8.33	33996	7.02
Vegetables	2	16.67	55628	11.47
Spices	1	8.33	22256	4.59
<i>FIFTH RANKING</i>				
Wheat	3	25	154904	31.95
Oilseeds	3	25	101203	20.87
Pulses	1	8.33	35950	7.43
Potato	2	16.67	86161	17.77
Tobacco	2	16.67	85736	17.68
Spices	1	8.33	20848	4.30
<i>SIXTH RANKING</i>				
Wheat	4	33.33	153130	31.59
Pulses	1	8.33	44115	9.10
Potato	5	41.68	218784	45.13
Tobacco	1	8.33	34780	7.17
Spices	1	8.33	33996	7.01
<i>SEVENTH RANKING</i>				
Wheat	2	16.67	85736	17.68
Oilseeds	1	8.33	69946	14.44
Pulses	3	25	99969	20.62
Potato	2	16.67	34780	7.17
Spices	4	33.33	194374	40.09
Total	12	100	484808	100

7.3 Crop Combination

7.3.1 Introduction

In order to understand the cropping patterns, the crop concentration, and agricultural operations in Koch Bihar district the study of crop combination is inevitable. It gives an idea about the agricultural typology, economics of agriculture and agricultural income of the district as well as it gives an insight in the cropping practices and crop rotation to recover the soil fertility. In this context, J. C. Weaver (1954) rightly stated that *to study the regional and economic geography in terms of agriculture, one country confined to the description of dominant individual crop/crops rather than complex agricultural system, with the result that the country suffers from over generalizations, because the individual crops, except in relatively rare circumstances of extreme mono culture, is not grown alone but characteristically they appear in combinations.* J. C. Weaver (1954) also pointed out 3 different reasons in which crop-combinational analysis may have more fruitful: (i) these are essential to an adequate understanding of individual crop geography; (ii) crop combination in itself is an integrated reality that demands definitions and distributional analysis and (iii) such regions are essential for the construction of the still more complex structure of vivid agricultural regions.

7.3.2 Methodology:

Minimum deviation method as developed by J. C. Weaver (1954) and the method developed by K. Doi (1959) have been applied to study the crop-combination regions of Koch Bihar district. J C. Weaver, the pioneer of quantitative idea, formulated this minimum deviation method in 1954 to study the crop-combination regions in the Middle West (U.S.A.). Weaver has considered percentages of crops acreages to gross cropped area (G.C.A) and the percentages mentioned above are arranged in decreasing order.

Weaver considered the percentages of crops acreages to gross cropped area (GCA) arranging in descending order. Weaver considered crop that covers 100% of GCA is mono-culture or, single crop; crops that cover 50% of GCA for each crop be defined as 2-crop combination; crops that cover 33.3% of GCA for each crop be defined as 3-crop combinationand so on. The crop combination would be finally obtained from the following formula:

$$\sigma = \sqrt{\sum(d^2) \div n} \dots\dots\dots 7.1$$

where: σ = standard deviation, $\sum d^2$ = sum of the squares of deviations and n = number of crops.

The formula for calculating the crop combination by K. Doi's method is as follows:

$$\sum(d^2); \text{ Where, } \sum d^2 = \text{sum of the squares of deviations}$$

The combination having the smallest $\sum d^2$ will be the combination of the primary crops. But it is not required to calculate $\sum d^2$ for each combination, as it can be found only by consulting a table provided by Doi which presents critical values for different element at various cumulative percentage. If the percentage held by a single crop is lower than the critical value, the crop is dropped from the combination and vice versa.

Table 7.7a

Block-wise gross cropped area under different crops in Koch Bihar district

SL No	Name of blocks	Paddy		Wheat		Jute		Oil Seeds	
		1980-81	2004-05	1980-81	2004-05	1980-81	2004-05	1980-81	2004-05
1	Mekhliganj	17150	17900	1610	2980	5670	5020	800	1455
2	Haldibari	14310	11340	490	150	4940	4560	1100	510
3	Mathabhanga-I	26932	26800	920	1160	6335	4880	500	2160
4	Mathabhanga-II	28400	22850	1450	1810	8705	8750	700	1920
5	Sitalkuchi	20300	22300	420	320	5045	4560	400	970
6	Koch Bihar I	27541	31150	1350	2170	9210	9030	1400	3730
7	Koch Bihar II	32124	27220	1420	2560	7260	6620	1000	3980
8	Tufanganj- I	26122	28930	1250	1960	6725	5470	2100	4830
9	Tufanganj- II	18971	20230	770	1080	5640	1290	700	5060
10	Dinhata I	25604	22230	1050	1360	6280	4290	610	2890
11	Dinhata II	21397	26980	1440	1620	6030	9400	560	3050
12	Sitai	13940	11390	500	400	3560	1990	200	136
13	Total	272791	269320	12670	17570	75400	65860	10070	30691

Table No. 7.7b

Block-wise gross cropped area (GCA) under different crops in Koch Bihar district

SL No	Pulses		Potato		Green Vegetables		Spices		Tobacco	
	1980-81	2004-05	1980-81	2004-05	1980-81	2004-05	1980-81	2004-05	1980-81	2004-05
1	695	350	190	2370	420	2407	80	498	1900	1800
2	617.25	160	80	220	480	3807	150	1509	160	-
3	935	1260	160	670	570	5012	175	734	1400	1439
4	548.3	770	290	2560	500	5442	145	774	450	75
5	490.15	330	100	380	265	2457	170	393	2100	2286
6	1038.18	1435	170	1520	565	5797	110	793	1260	1240
7	715.12	600	200	3970	740	5677	190	754	250	-
8	549.22	495	130	1090	650	5457	170	774	90	-
9	940.3	1175	120	1030	560	5322	155	763	30	-
10	557.1	530	280	1810	770	5767	195	644	2000	2100
11	552.25	476	80	1040	640	5112	140	733	560	625
12	462.13	380	0	180	150	1419	20	403	3900	4550
13	8100	7961	1800	16840	6310	53679	1700	8772	14100	14115

Source: District Agriculture Annual Plan, 2007-08

7.3.3 Crop Combination

7.3.3.1 Period I (1980-81):

Based on K. Doi's method, during the year 1980-81 the district was dominated by mono crop combination and out of 12 blocks in the district, monoculture was dominant in 10 blocks while the remaining 2 blocks namely Haldibari and Mekhliganj have been characterised by two crop combinations (Table 7a & 7b). The blocks dominant in monoculture have been identified as Mathabhanga I and II, Sitalkuchi, Koch Bihar I and II, Tufanganj I and II, Dinhata I and II and Sitai. Paddy was the single dominant crop in all these blocks (Fig. No, 7.1a & 7.1b).

On the hand, based on the Weavers' method, the district was dominated by two crops combinations and out of the 12 blocks of the district, 9 blocks were dominated by 2 crops combination of paddy and jute. Only one block namely Koch Bihar II was under mono crop with paddy and another block namely Mathabhanga II was dominated by 3 crops combinations of paddy, Jute and wheat (Fig. No, 7.1a).

Table 7.8 Crop Combination in Koch Bihar District (1980-81)

Name of blocks	Crop Combinations (J.C. Weaver)	Crop Combinations (K. Doi)
Mekhliganj	2 crops (paddy & jute)	2 crops (paddy & jute)
Haldibari	2 crops (paddy+Jute)	2 crops (paddy & jute)
Mathabhanga-I	2 crops (paddy & jute)	Mono crop (paddy)
Mathabhanga-II	3 crops (paddy, jute & wheat)	Mono crop (paddy)
Sitalkuchi	2 crops (paddy & jute)	Mono crop (paddy)
Koch Bihar I	2 crops (paddy & jute)	2 crops (paddy & jute)
Koch Bihar II	Mono crop (Paddy)	Mono crop (paddy)
Tufanganj- I	2 crops (paddy & jute)	Mono crop (paddy)
Tufanganj- II	2 crops (paddy & jute)	Mono crop (paddy)
Dinhata I	2 crops (paddy & jute)	Mono crop (paddy)
Dinhata II	2 crops (paddy & jute)	Mono crop (paddy)
Sitai	3 crops (paddy, tobacco & jute)	2 crops (paddy & tobacco)
Total	2 crops (paddy & jute)	Mono crop (paddy)

7.3.3.2 Period II (2004-2005)

During the study period from 1980-81 to 2004-2005, there is a significant change in the crop combinations and the district has been found to be dominated by 2 crops and 6 crops combination based on Doi's and Weavers method respectively. It is observed from the table 12 B that not a single block falls under the mono crop combination. All the blocks fall under 3 to 7 crop combination region based on Weaver's method (Fig. 7.2a).

7.3.3.2.1 Three crop combination

Haldibari is the only block identified as three crops combination region situated in the extreme south-western part of the district. Paddy is the dominant and distinctive crop as well as first ranking crop while the second ranking crop is jute and third ranking crop is vegetables.

7.3.3.2.2 Four crop combination

This combination has been identified in Sitalkuchi and Sitai block. In Sitalkuchi the dominant crop association is paddy - jute -vegetables - tobacco and in Sitai the combination has been found as paddy - tobacco - jute - vegetables covering area of 65.6%, 13.41%, 7.23%, 6.72%, 54.63%, 21.82%, 9.55% and 6.81% respectively. From the analysis it is clear that the Sitalkuchi and Sitai blocks are transformed from two crops to four crops combination region during the study period (1980-81 to 2004-2005). The transformation from staple food (paddy) and traditional cash crop jute to vegetables.

7.3.3.2.3 Five crop combination

Five crops combination spreads over four blocks namely Mathabhanga I, Koch Bihar I, Tufanganj I, and Dinhata II with a combination of paddy-jute-vegetables-oilseeds-wheat common to all everywhere.

7.3.3.2.4 Six crop combination

Three blocks namely Mathabhanga II, Koch Bihar II and Tufanganj II have been identified with six crop combination of paddy-jute-vegetables-potato-oilseeds-wheat in Mathabhanga II and Koch Bihar II. A combination of paddy-vegetables-oilseeds-jute-pulses-wheat has been identified in Tufanganj II block.

7.3.3.2.5 Seven crop combination

Mekhliganj block has been identified with 7-crop combination of paddy-jute-wheat-vegetables-potato-tobacco-oilseeds and Dinhata I block with a combination of paddy-vegetables-jute-oilseeds-tobacco-potato-wheat.

Table No. 7.9 Change in crop combination regions in Koch Bihar (1980-81 to 2004-05)

Crop Combination	Based on J. C. Weaver				Based on K. Doi			
	No. of blocks		Change		No. of blocks		Change	
	1980-81	2004-05	Increase	Decrease	1980-81	2004-05	Increase	Decrease
Monoculture	1	0	-	1	8	1	-	7
Two Crop	9	-	-	9	4	7	3	-
Three Crop	3	1	-	2	-	4	4	-
Four Crop	-	2	2	-	-	-	-	-
Five Crop	-	4	4	-	-	-	-	-
Six Crop	-	3	3	-	-	-	-	-
Seven Crop	-	2	2	-	-	-	-	-
Total	12	12	12	12	12	12	12	12

Discussion

The pattern of combinational change as per Weaver's technique shows that during the period 1980-81 monoculture observed in one block, two crops combination dominated in nine blocks and three crops combination dominated in the remaining three blocks of the district. However, by the year 2004-05 both monoculture and two crops combination have been found non-existent. There has been a combinational change towards larger number of crops i.e., three crops, four crops, five crops, six crops and seven crops respectively. The strength of monoculture and two crops combination has been decreased by 100% and the strengths of three crops combination decreased by 66.66%. On the other hand, there is

significant increase in the block level under higher degree of crop combination i.e., four to seven crops.

Table 7.10 Changing pattern of cropped area in % in 1980-81 and 2004-05 in Koch Bihar

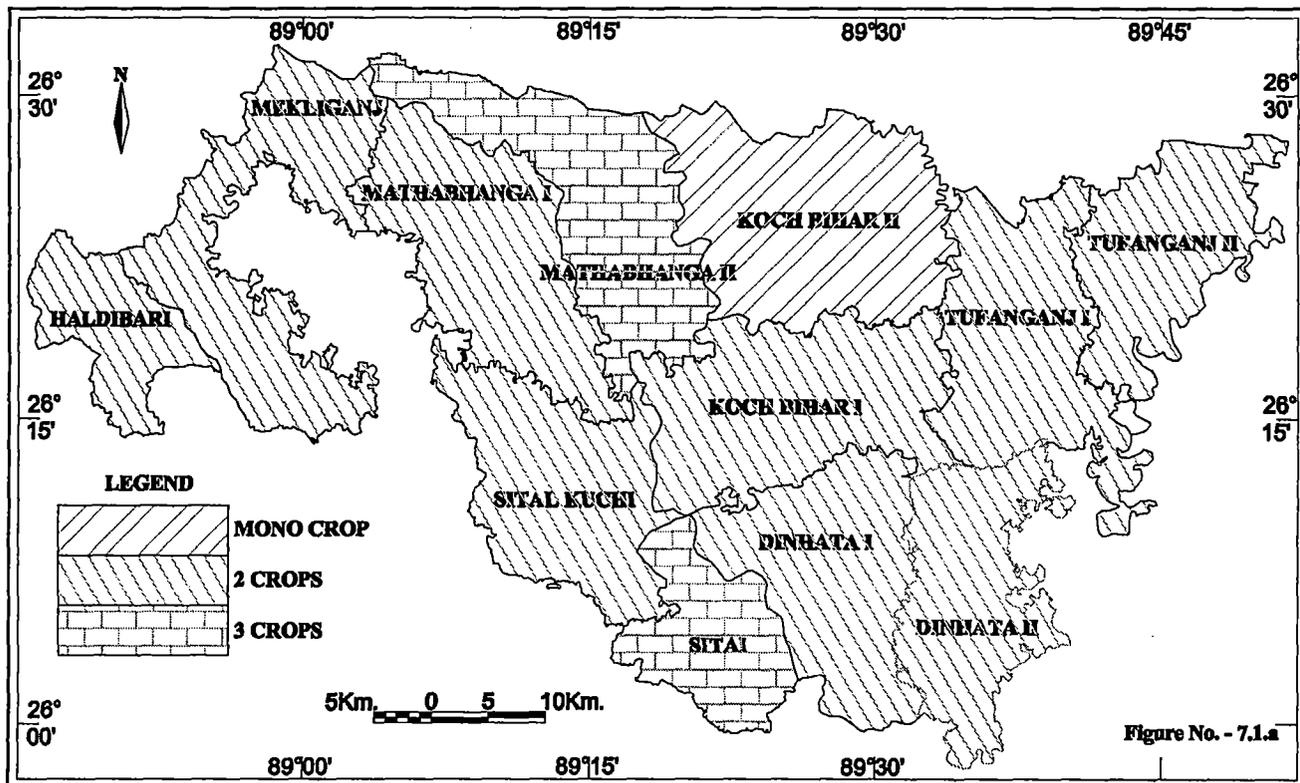
Crops	Area in 1980-81		Major crop combination	Crops	Area in 2004-05		Major crop combination
	(in hectare)	(in %)			(in hectare)	(in %)	
Paddy	272791	67.63	Mono crop by Doi (Paddy)	Paddy	269320	55.55	2-crops by Doi (Paddy + Jute)
Jute	75400	18.69		Jute	65860	13.58	
Tobacco	14100	3.50		Vegetables	53679	11.07	6-crops by Weaver (Paddy+Jute+Vegetables+Oilseeds+Wheat+ Potato)
Wheat	12670	3.14		Oilseeds	30691	6.33	
Oilseeds	10070	2.50	2-crops by Weaver (Paddy + Jute)	Wheat	17570	3.62	
Pulses	8100	2.01		Potato	16840	3.47	
Vegetables	6700	1.66		Tobacco	14115	2.91	
Potato	1800	0.45		Spices	8772	1.81	
Spices	1700	0.42		Pulses	7961	1.64	
Total	484808	100.00					

On the other hand, based on K. Doi's method it has been identified that during the year 1980-81 mono-crop and two crops combination occupied in eight and four blocks of the district. This combinational pattern has changed during the period of 2004-05 showing mono crop in one block, two crops in seven blocks and three crops combination in the remaining four blocks. Significant decrease of 87.5% in mono culture has been noticed by the period. While, significant increase has been noticed in three and four crops combination in the same period and which has been estimated to be 42.86% and 400% respectively.

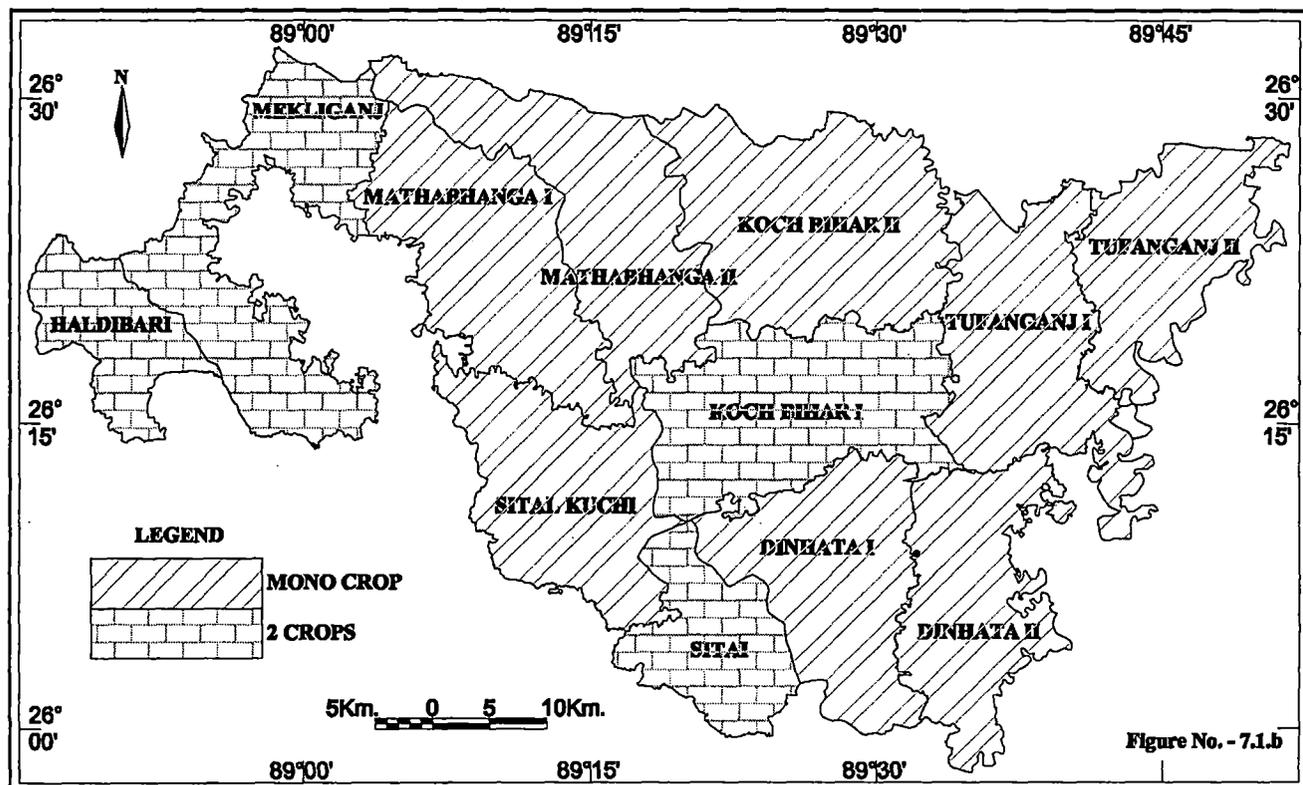
Table 7.11 Crop Combination in Koch Bihar District (2004-05)

Name of blocks	Crop Combinations (J.C. Weaver)	Crop Combinations (K. Doi)
Mekhliganj	7 crops (paddy-jute-wheat-vegetable-potato-tobacco-oilseed)	2 crops (paddy-jute)
Haldibari	3 crops (paddy-jute-vegetables)	3 crops (paddy-jute-vegetables)
Mathabhanga-I	5 Crops (paddy-vegetables-jute-oilseeds-tobacco)	2 crops (paddy-vegetables)
Mathabhanga-II	6 crops (paddy-jute-vegetables-potato-oilseeds-wheat)	2 crops(paddy-jute)
Sitalkuchi	4 crops (paddy-jute-vegetables-tobacco)	Mono crop (paddy)
Koch Bihar I	5 crops (paddy-jute-vegetables-oilseeds-wheat)	2 crops (paddy-jute)
Koch Bihar II	6 crops(paddy-jute-vegetables-oilseeds-potato-wheat)	3 crops (paddy-jute-vegetables)
Tufanganj- I	5 cops (paddy-jute-vegetables-oilseeds-wheat)	2 crops (paddy-jute)
Tufanganj- II	6 crops (paddy-vegetables-oilseeds-jute-pulses-wheat)	3 crops (paddy-vegetables-jute)
Dinhata I	7 crops (paddy-vegetable-jute-oilseeds-tobacco-potato-wheat)	3 crops (paddy-vegetables-jute)
Dinhata II	5 crops (paddy-jute-vegetables-oilseeds-wheat)	2 crops (paddy-jute)

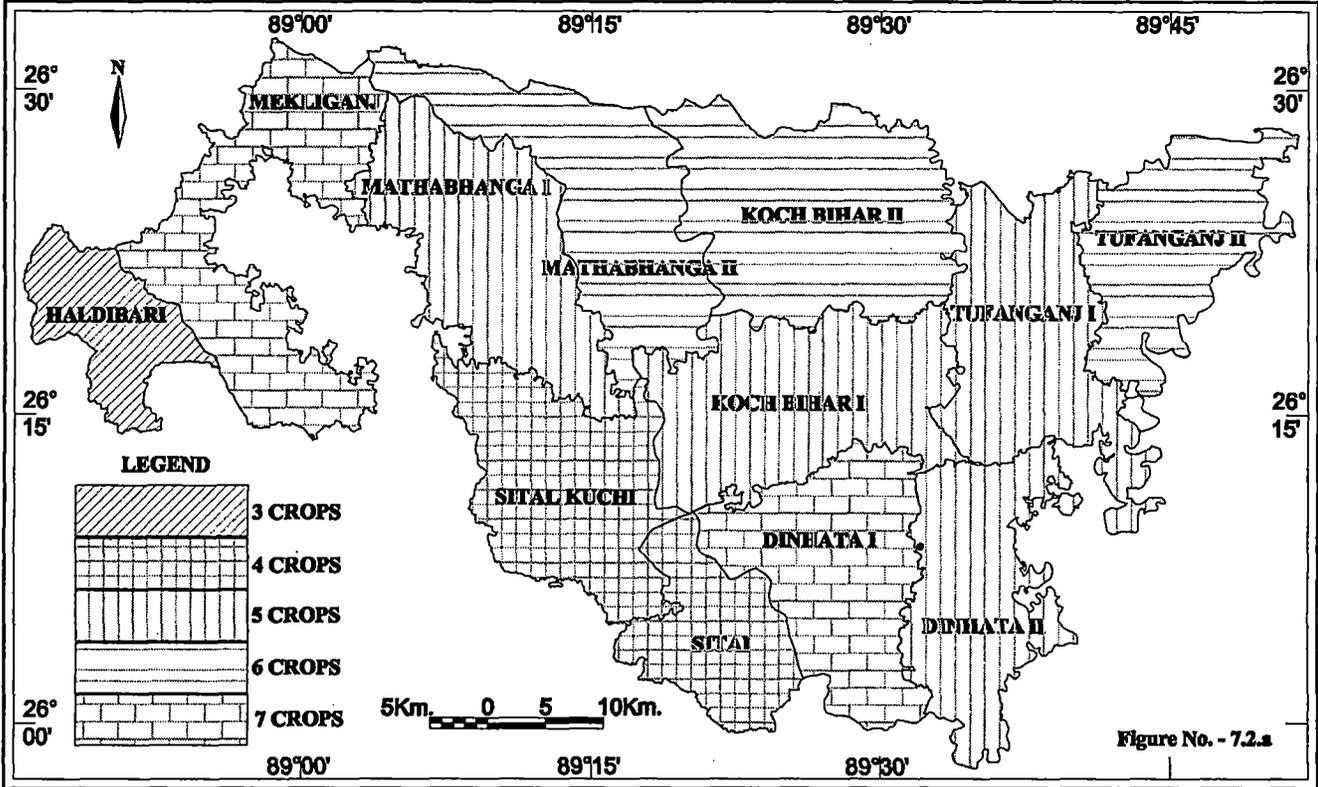
CROP COMBINATION REGIONS BASED ON WEAVER'S METHOD (1980-81)



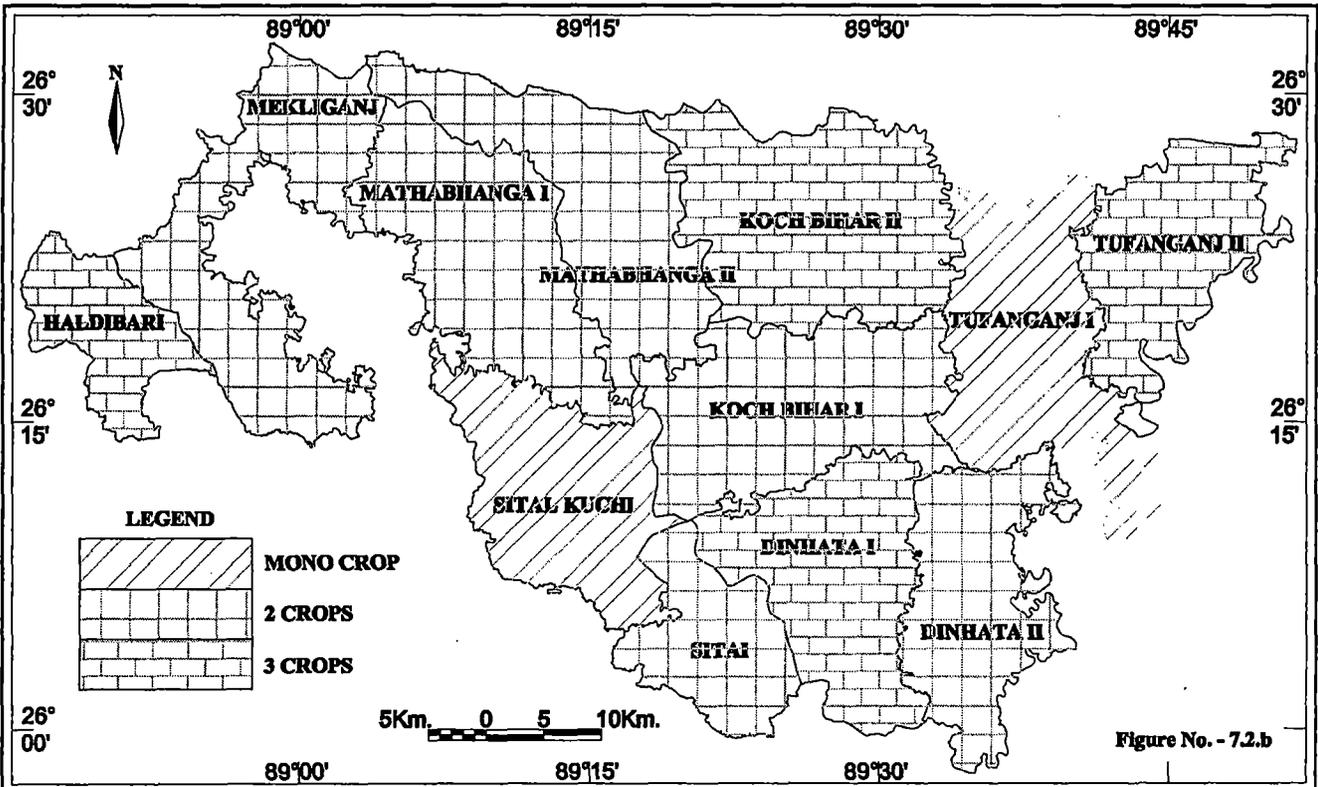
CROP COMBINATION REGIONS BASED ON DOI'S METHOD (1980-81)



CROP COMBINATION REGIONS BASED ON WEAVER'S METHOD (2004-05)



CROP COMBINATION REGIONS BASED ON DOI'S METHOD (2004-05)



7.4 Crop Diversification:

A study of crop diversification is necessary to understand the agricultural land use pattern in a particular region. Crop diversification means growing of various types of crops on land under cultivation. It is a technique which reflects the impact of physio-socio-economic factors but the most important is the physical environment. In general it appears that high degree of competition among various types of crops, rotation for field for maintaining the soil fertility and to acquire net benefit from the multiple cropping leads to diversification of crops. The greater number of crops leads to greater competition, the higher is the magnitude of diversification.

7.4.1 Methodology:

The pattern of crop combination when observed with diversification indicates that greater the number of crops in combination, higher is the diversification. In order to identify the spatial patterns of crop diversification in the district under study Bhatia's method has been used. The formula of S. S. Bhatia's crop diversification is as follow:

Index of Crop Diversification = % of cultivated area under x crop / No. of x crop

Where, x means $\geq 5\%$ of area under crop i.e., x crops those which individually occupy 5% or more to net area in the block.

The indices of crop diversification have been calculated for two periods, 1980-81 and 2004-2005 and been displayed in tables and maps. Table 12 & figures 7.5 and 7.6 show the spatial patterns of crop diversification in the district.

7.4.2 Crop Diversification in Period I (1980-81)

The largest area for the period 1980-81 occurs in the low crop diversification group covering 61.36% area in the district and for the period 2004-05 occurs in the moderate crop diversification group covering 57.13% area in the district. It is seen from the table 14.3 that

two crops namely paddy and jute were in competition for diversification in 7 blocks (58.34% to total blocks), 3 crops were in competition for diversification in 4 blocks (33.33% to total blocks) with different crop association (3 for same association) and four crops were in competition for diversification in 2 blocks (8.33%) in the district.

Table 7.12 Block-wise crop diversification pattern (Based on Bhatia)

Block	Crop diversification (1980-81)	Crop diversification (2004-05)
Mekhliganj	23.1 (Paddy+Jute+Wheat+Tobacco)	15.6 Paddy+Jute+Wheat+Vegetable+Potato+Tobacco)
Haldibari	43.1 (Paddy+Jute)	23.8 (Paddy+Jute+Vegetable+Spices)
Mathabhanga-I	43.8 (Paddy+Jute)	27.7 (Paddy+Jute+Vegetable)
Mathabhanga-II	45.0 (Paddy+Jute)	22.0 (Paddy+Jute+Potato+Vegetable)
Sitalkuchi	31.2 (Paddy+Jute+Tobacco)	23.2 (Paddy+Jute+Tobacco+vegetable)
Koch Bihar I	43.0 (Paddy+Jute)	21.9 (Paddy+Jute+Oilseed+Vegetable)
Koch Bihar II	42.2 (Paddy+Jute)	18.5 (P+J+Po+Oil+Veg)
Tufanganj- I	30.8 (Paddy+Jute+Oilseeds)	22.8 (Paddy+Jute+Oilseed+Vegetable)
Tufanganj- II	44.1 (Paddy+Jute)	28.4 (Paddy+Oilseed+Vegetable)
Dinhata I	30.2(Paddy+Jute+Tobacco)	17.9(Paddy+Jute+Oilseed+Tobacco+Vegetable)
Dinhata II	43.6 (Paddy+Jute)	22.7 (Paddy+Jute+Oilseed+Vegetable)
Sitai	31.4 (Paddy+Jute+Tobacco)	23.2 (Paddy+Jute+Tobacco+Vegetable)
Total	43.2 (Paddy+Jute)	21.6 (Paddy+Jute+Oilseed+Vegetable)

7.4.3 Crop Diversification in Period II (2004-05)

In contrast, the period 2004-05 exhibits a keen competition for crop diversification. During this period Three crops namely Paddy, jute vegetables in Mathabhanga II and paddy, jute, oilseeds in Tufanganj II are in competition for diversification in 2 blocks (16.67%), Competition for four crop diversification is observed in 7 blocks of the district (58.33% to total block). However, there is a different cropping association among the four blocks. Four crops namely Paddy, Jute, Vegetables, spices are in competition for diversification in Haldibari block; paddy, jute, oilseeds, vegetables are in competition in 3 blocks namely Koch Bihar I, Tufanganj I and Dinhata II; paddy, jute, tobacco, vegetables are in competition in 2 blocks namely Sitalkuchi and Sitai; Paddy, Jute, Potato, Vegetables are in competition in 1 block namely Mathabhanga II. Five crops namely Paddy, Jute, Potato, oilseeds, vegetables are in competition for diversification in Koch Bihar II and paddy, jute, oilseeds, tobacco, vegetables in Dinhata I. Only the Mekhliganj block exhibits six crop competition for

diversification namely paddy, jute, wheat, vegetables, potato and tobacco (8.33% to total blocks).

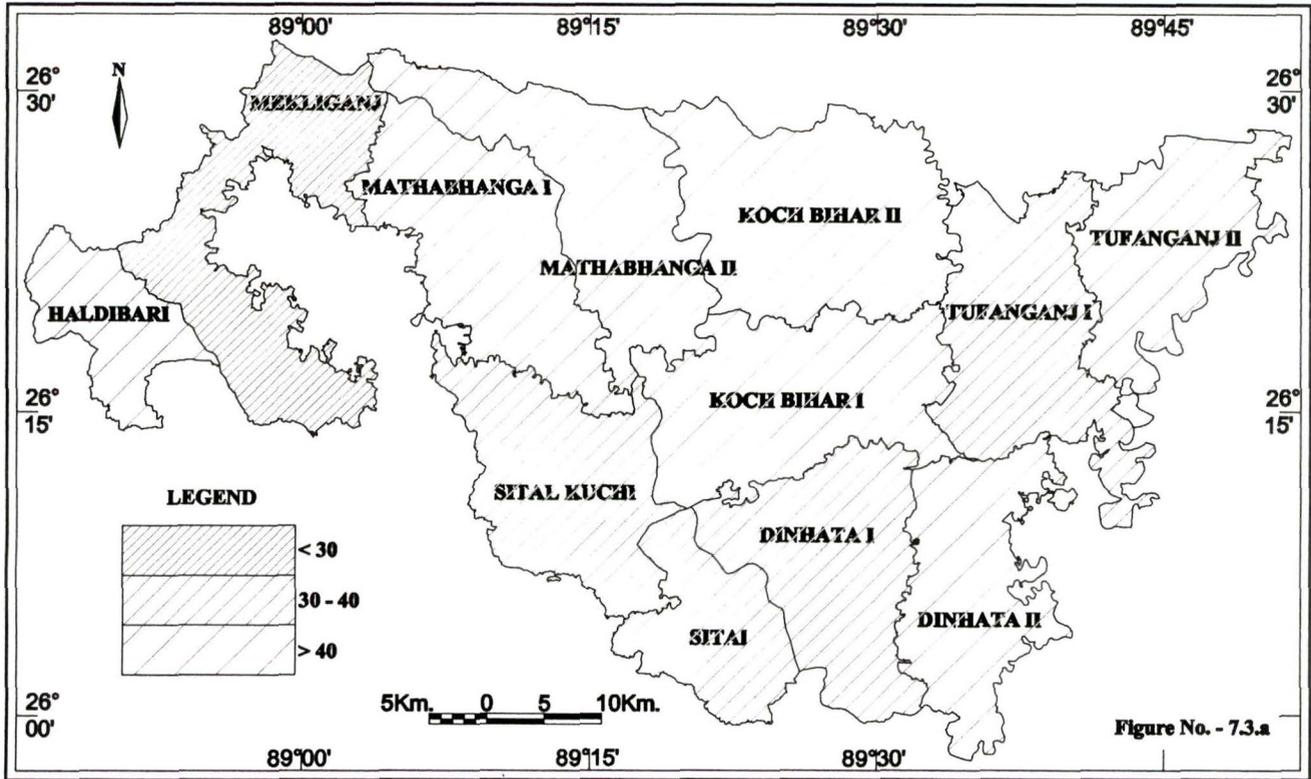
Therefore, it can be summarized that during the period 2004-05 crop is more diversified than that of the 1980-81 period. The low degree of diversification during 1980-81 may be due to: a) traditional farming practice; b) ignorance of farmers about modern cropping pattern; c) high degree of dependency on monsoon rain; d) lack of modern inputs; e) traditional ownership of land; f) dominance of traditional varieties of seeds.

On the contrary, the period under study from 1980-81 to 2004-05 the observed pattern of crop is more diversified which may be accounted for increased rate of population pressure on agricultural land, introduction of HYVs seeds, use of fertilisers and manures, effectiveness of land reforms, provision of irrigation facilities.

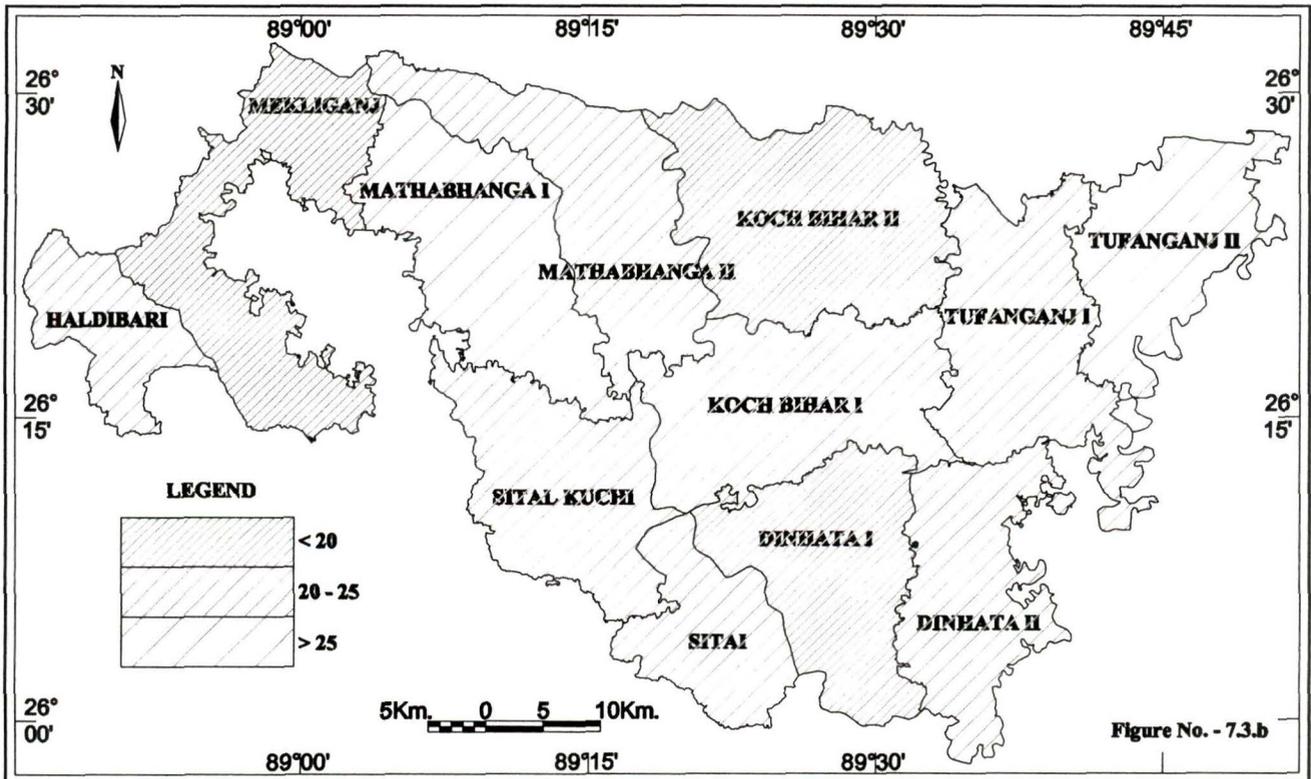
Table 7.13 Trends in crop diversification in Koch Bihar district

Sl No.	Di. Index	Diversification Class	1980-81		2004-05	
			No. of blocks	Area covered (%)	No. of blocks	Area covered (%)
1	< 20	Very High	-	-	3	26.36
2	20-25	High	1	7.07	7	57.13
3	25-30	Moderately High	-	-	2	16.51
4	30-35	Moderately Low	4	31.57	-	-
5	35-40	Low	-	-	-	-
6	>40	Very Low	7	61.36	-	-

CROP DIVERSIFICATION REGIONS (1980-81)



CROP DIVERSIFICATION REGIONS (2004-05)



7.4.4 Crop Diversification Regions

The results obtained have been displayed in above Table and presented by choropleth map shows that crops in number, crops in competition, number of blocks and index of crop diversification in the district. The following five crops diversification regions have been categorized:

- i) Very high crop diversification
- ii) High crop diversification
- iii) Moderately high crop diversification
- iv) Moderately low crop diversification
- v) Very low crop diversification

7.4.4.1 Very high crop diversification

Very high crop diversification has been identified in three blocks namely Mekhliganj, Koch Bihar II, Dinhata 1 covering 14.39% of the gross cropped area. Large number of crops is found in very high degree of diversification including paddy, jute, wheat, green vegetables, potato, tobacco and oilseeds.

7.4.4.2 High crop diversification

This category covers 34.4% of the gross cropped area. The index value of this category ranges from 20 to 25 and has been identified only in Mekhliganj block in 1980-81 and in Haldibari, Mathabhanga II, Sitalkuchi, Koch Bihar I, Tufanganj I, Dinhata II and Sitai in 2004-05. This category occupies three to four types of crop.

7.4.4.3 Moderately high crop diversification

The area of moderately high crop diversification covers 9.01% of the gross cropped area in the region under study. Two blocks in 2004-05 namely Mathabhanga I and Tufanganj

II identified under this category. The range of diversification of this category is from 25 to 30 and three types of crops enter this category.

7.4.4.4 Moderately low crop diversification

Moderately low crop diversification covers 14.33% of the gross cropped area in Koch Bihar district. Four blocks in 1980-81 namely Sitalkuchi, Tufanganj I, Dinhata and Sitai identified under this category. The range of diversification of this category is from 30 to 35 and three types of crops enter this category.

7.4.4.5 Very low crop diversification

This category covers 27.87% of the gross cropped area. The index value of this category ranges more than 40 and seven blocks namely Haldibari, Mathabhanga I, Mathabhanga II, Koch Bihar I, Koch Bihar II Tufanganj II and Dinhata II in 1980-81 enter this category. This category occupies two types of crop namely paddy and jute.

7.5 Conclusion

From the above analysis it is revealed that very high to high diversification of crops dominate in 2004-05 while moderate low and very low diversification dominated during the period 1980-81. It can be mentioned that high diversification during the period 2004-05 indicates the availability of fertilisers, pesticides, intensive agricultural practice, expansion of irrigation facility, population pressure on land, use of HYVs etc. On the other hand, low degree of diversification during 1980-81 may be attributed to traditional way farming practice, dependency on monsoon rainfall, low quality of seeds, limited use of chemical fertilisers etc. Thus, the result of crop diversification established the relation with physico-socio-economic condition of the district.

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