ABSTRACT

The study area like Koch Bihar district where majority of the people are employed in agriculture and where agriculture contributes lion's share of its livelihood, the rate of growth of economy as a whole, largely, depends upon the rate at which her agricultural sector grows. During the close of the last century, the agricultural scenario of Koch Bihar district has been changed keeping pace with the increasing agro-modernisation. The cropping pattern has been changed and the production as well as productivity of various crops has also been increased. In spite of these, a close examination of the present agricultural status of the district unfolds the facts that the hike of costs of various inputs of farming has reduced the affording capacity of farmers, fragmentation of land holding, stagnancy of productivity of crops at a certain level. Fluctuation of market price in erratic manner has also decreased the margin of profit year after year resulting frequent distressed cases of farmers under debts. As a result, a significant percentage of farming community has compelled to shift their occupation from agriculture to other sector. The present study has been carried out to analyse, assess and interpret the pattern of agricultural land use with that of past decades in Koch Bihar district.

The district of Koch Bihar is one of the backward districts of West Bengal. It stretches roughly between the 25°58'N to 26°33'N latitudes and 88°48' E to 89°55'E meridians. The district is bordered on the north and north-west by Jalpaiguri district, east by Assam state and south and south-east by Bangladesh. The district covers an area of 3387.0 sq. km, which accounts for about 3.82% of the total geographical area of West Bengal. The district is divided into12 development (CD) blocks.

Geomorphologic history of Koch Bihar district has been characterized by successive catastrophic events of accelerated deposition during the post-Pleistocene period. Uplift of the Himalayas during the Quaternary time led to the creation of faults parallel and transverse to the Himalayas in North Bengal. These faults at some place tend along courses of rivers, often causing shifting of river channels in this region. According to the accounts of former and present geologists, the whole of North Bengal has from time to time, experienced subsidence and upliftment due to faulting. This has caused river incision, creation of swamps, escarpments, river shifting etc. at different places. The northern part of North Bengal is largely made up of glacial and fluvio-glacial deposits of the Quaternary period, while most of

the southern part including Koch Bihar district consists of Pleistocene to Recent flood plain deposit. Perceptible gentle gradient of land is a significant feature of Koch Bihar district. The district is essentially a flat country with a slight southeasterly slope along which the rivers flow. Maximum altitude of the district is 75 m, and the minimum is 28 m with a relative height is 47 m.

Koch Bihar has a network of perennial rivers and ephemeral streams. The rivers are mostly flow along the course from north-east to south-west. The major rivers are originated in the Himalayas and entered the district from the western Duars of Jalpaiguri and after flowing through the district, they enter the Rangpur district of Bangladesh to discharge into the river Bramhaputra. Rivers flow through meandering courses and floods are common during the rainy months. Bed load is deposited close to the channel and suspended load with finer silt and clay accumulates in back swamp areas away from the river channels. Where flooding is not frequent, lateral accretion and channel deposition are more significant in the formation of floodplain. Six river systems cut through the district flowing in a southeasterly direction. From the west to the east these are: a) the Tista system; b) the Jaldhaka system; c) the Torsa system; d) the Kaljani system; e) the Raidak system and f) the Gadadhar system. The rivers are notorious for frequent flood followed by inundation, bank erosion and avulsion.

The climate is characterised by strong hot and humid conditions and controlled by the strong presence of south west monsoon. Mean annual temperature ranges from 9°C in January to 33°C in the month of July-August. The range of temperature is very high i.e., 22°C. The cold season is from mid November to the end of the February. This is followed by the hot season from March to May. The highest ever recorded temperature at Koch Bihar 39.9°C in May 1960 and the lowest minimum temperature was 3.9°C in January, 1955.

Analysis of long term rainfall data (1923-2007) identify Koch Bihar as the rainiest district in West Bengal with mean annual rainfall reaching 3311.7 millimeter of which 3093.9 millimeter descends during the 6 monsoon months between May and October. The period from June to end of September is the south-west monsoon season. Pre-monsoon season starts from mid March (*Kalbaisakhi* or Nor'wester) which facilitates the sowing *Zaid* crop. The rainfall pattern in the district is found not only erratic but also fluctuating putting tremendous stress to the agro-economy.

The atmosphere remains humid throughout the year. During the month of February to May, the relative humidity is less, being only between 50% and 70%. During October to April, sky is generally clear. The cloudiness increases from the month of May. On an average, Koch Bihar records 102 rainy days in a year which varies from 96 at Dinhata to 107 days at Koch Bihar and Tufanganj. Yearly average sunshine hours per day vary from 5.6 hour in rainy season to 7.6 hours in winter season in this district. The average potential evapo-transpiration of the district is about 98.22 mm which varies from maximum of 151.8 mm in April to 51.3 mm in December.

The soil of Koch Bihar is alluvial of very recent formation. The soil is mostly sandy loam and in most part the depth is about 1 m and in some places even less than that. The soil in most part of the district is of ash colour. Black loam is also found in eastern part of the district bordering the state of Assam to the east of the river Kaljani. Dark loam is also found in the region between Jaldhaka and the Tista and in the paleo-channels of Dharala.

Average organic carbon, phosphorus (P_2O_5) and Potassium content (K_2O) is 1.80%, 2.3% and 1.78% respectively. This kind of soil of medium fertility status requires thorough reclamation through application of lime or dolomite in combination with green manuring crops (*Dhaincha* or with bio fertilizers like Azophos/ Rhizophos or Vermi-compost etc). Increased use of organic manure in recent years indicates the growing awareness among the farmers regarding utility and necessity of organic farming. Micro-nutrient deficiency is distinctively visible in different crops. Specially, deficiency of Boron, Molybdenum, and Zinc is in a very alarming stage.

The district lacks in heavy textured soil. Over 66% of the total cultivated soil may be defined as light textured and the remaining 34% has been classified as medium textured soil. Sandy clay loam is the most common texture in Koch Bihar district, which constitute about 53% of total cultivated soil. The soils of Koch Bihar district is strong to moderately acidic in nature with pH varies from 4.1 to 5.6 which often shows detrimental effect in productivity and crop selection. It has been found that soil acidity is a common phenomenon irrespective to spatial location, however, the problem has been found most acute in Sitalkuchi, Tufanganj I & II, Sital and Haldibari block. The acidity problem has been found least in Mathabhanga II, Koch Bihar I and Koch Bihar II block.

Koch Bihar is a district covered with abundant natural vegetation. Among the trees the most conspicuous is the red cotton tree (*Bombax malabaricum*), Sissu (*Dalbergia sissoo*), Mango (*Mangifera indica*), Jack Fruit, Sal (*Shorea robusta*), Mahua, Teak, Bamboo, Khayer (*Acacia catechu*), Palms etc. Koch Bihar district at present has no large forest. There are two small forests which are Bochamari-Chengtimari forest & Patlakhawa forest. In 1980-81, the total amount of forest was 5700 hectares and it declined a nominal amount by 4765 hectares in 2004-05.

The immigration of displaced people from East Pakistan (now Bangladesh) started since 1950-51. The population of the district was 668,949 in 1951 which was increased to 2479,155 persons as per 2001 census, registering an increase of 270.47% during the last five decades. Over the decades, highest growth rate of population (52.45%) was recorded during the decade 1951-1961. In fact, it was the highest among all the districts of West Bengal. The district of Koch Bihar is almost entirely rural. The percentages of rural population to the total population of the district as per the 1951 and 2001 census are 92.50% and 90.90% respectively. There is high concentration of scheduled caste population which was 40.15% in 1951 and further increased to 50.1% in 2001. On the other hand, the percentage of ST population in the district is very negligible. As per 2001 census, the literacy rate in the district is 66.3% which is lower than the state average of 69.22%.

The density of population in the district is increasing steadily since the 1951 from 198 to 732 persons per sq. km in 2001. There are considerable spatial variations in the density distribution within the district. During the year 1981 the highest density was observed in Dinhata I block while the lowest density was noticed in Haldibari block.

The occupational pattern of population of the district also reveals that the majority of main workers are engaged in agricultural activities. As per 2001 Census, 39% of the total population of the district is main workers which consist of 37.43% cultivators, 29.5% agricultural labourers and 4.06% household industrial workers. The occupational pattern of the population of the district is mainly characterized by agriculture and related activities. The growth of agricultural labourers of the district also surpassed the growth of the state average over the decades.

The agrarian sector of the district is largely dominated by small and marginal peasants. In fact, the numbers of large holdings as well as area accounted for are very negligible and have steadily declined in the district over the years. In the year 2004-05, 61.9% of the holdings in the district are below 2 acres which covers 75.53% area of total holdings.

The area under forests in the district has been decreased (16.40%) during the period of 25 years. The land put to non-agricultural uses including area under roads, railways and settlements which accounted for 46230 hectares in the year 1980-81 and 60786 hectares in the year 2004-05, showing an increase of 31.49% over the period. Koch Bihar district accounts for 253863 hectares net sown area to the total geographical area in the year 2004-05. Therefore, during the period of study, there is a marginal decrease (1.51%) in the net sown area. The decrease in net cultivated area can be explained by the increase in the land under non -agricultural uses, permanent pastures. The double cropped area has been also increased tremendously registering 71.89% of net shown area in 2004-2005 from 47.08% in 1980-1981.The existing land use pattern shows that the proportion of land available for cultivation is quite high.

The cropping pattern of the district is mainly characterized by three major crops seasons: pre-monsoon (*Zaid* crops), monsoon (*Kharif* crops), winter (*Rabi* crops) crops. The overall cropping pattern of the district is dominated by food crops cultivation which accounts for 76.28% of the gross cropped area. Out of these, food grains alone occupy 60.23%. Among the food grains, paddy (54.49%) occupies the 1st position in terms of area while wheat ranks the next position which covers an area of 3.55%. Other food grains such as pulses, maize, fox tailed millets (*Kaun*) etc. occupy very small proportion in terms of area. On the other hand, amongst non-food crops jute (13.32%) is the leading crop followed by oilseeds and tobacco. The changes in the cropping pattern of the district during the study period (1980-81 to 2004-05) due to: i) intensive use of agricultural land; ii) introduction of HYVs; iii) use of chemical fertilizers and pesticides; iv) expansion of irrigation facilities and v) farm mechanization.

The study demonstrates negligible variations in the changing cropping pattern of cereals over the period between 1980-81 and 2004-05. Minor increase has been noticed in blocks like Mekhliganj, Mathabhanga I, Sitalkuchi, Tufanganj I and Dinhata I while negative changes recorded in the remaining blocks of the district. For pulses it is observed that

Mathabhanga I, Mathabhanga II, Koch Bihar I and Tufanganj II recorded positive change and rest of the blocks recorded negative change. Massive change has been recorded in oilseeds cultivation, Tufanganj II block recorded a massive 722.86% increase followed by Dinhata II 544.64%, Dinhata I 473.77%. Negative change has been recorded only in Haldibari and Sitai blocks. All the blocks registered positive change over the studied period in case of cash crops.

The area under paddy cultivation during the study period remains more or less same in the district as a whole. In the blocks where the increase in area was observed are mainly because of the availability of irrigational facilities and introduction of new HYVs while the decrease is identified due to the shifting of cultivation to the other crops. Hence, the Koch Bihar district is identified as *aman* paddy crop district. The growth trend also indicates that potato and vegetables has been gaining importance as money crops in the agriculture scenario of the district.

It is observed that the cropping intensity in the district is higher than the state average for both the periods of study. It is revealed that there is no change in high cropping intensity region as for both the period in Dinhata II block that ranks the highest cropping intensity (> 220) in the district. There were three moderately high cropping intensity blocks namely Tufanganj I, Sitai and Haldibari in the year 1980-81 where as this number increased to seven i.e., Haldibari, Mathabhanga I, Koch Bihar I & II, Tufanganj I & II and Sitai in the year 2004-05.

The agriculture is Koch Bihar is based on age-old experiences and most of the essential agro-implements are indigenous. Fertility of soils is maintained by using organic manures like cow dung and composite manures. Insufficient transport network in the district compelled the farmer to perform their agro-based transport by bullock carts and on human shoulder. Marketing facilities were almost absent. The role of the Government had largely been limited. Trade too was unfavourable and intermediaries made more profits than the cultivators did. As a result, the district's agriculture continued to function as the backward sector in the economy. However, shortly after 1980-81 especially with abolition of *Jotedari* system and introducing land reform system the inputs like irrigation, agricultural machinery, adoption of improved seeds, use of chemical fertilizers, pesticides, agricultural credit loans etc have been taken in to consideration.

Irrigation has become one of the most important inputs in boosting agricultural growth and the expansion of irrigation potential and its optimum utilization occupies a high priority in the programme of agricultural development. Irrigation facilities cover only 24.33% of the district's gross cropped area and only 39% of the net cropped area is under irrigation in the year 2004-05. The major sources of irrigation comprises of tanks and wells, deep tube wells, shallow tube wells and river lift pumps.

The consumption of fertilisers shows steady increase over the period from 1980-81 to 2004-05 mainly because of the modern application of agricultural practices by the farmers in the district. There is block-wise variation in the consumption pattern of fertilisers. During the study period, the district has observed an increase of about 439.96%, 420.84% and 346.41% in per hectare in consumption of N, P and K respectively.

FYM, cow dung, oil cake, vermi compost and green manure are the major types of organic fertilizers applied in Koch Bihar district. Cow dung is the largest form of bio-fertiliser has been found to be slightly decreasing in terms of use from 150000 in 2003-04 to 145000 MT in 2005-06. Accordingly, the cultivated area covered by cow dung has been decreased from 18750 in 2003-04 to 18125 hectare in 2005-06. It is also interesting to note that the percentage of farmer used cow dung as bio-fertiliser has been decreased from 85% in 2003-04 to 80% in 2005-06. FYM is another form of bio-fertiliser used in agriculture in Koch Bihar district that shows positive growth over the study period. The importance of oil cake as bio-fertiliser is gradually decreasing from 1500 metric ton in 2003-04 to 1000 metric ton in 2005-06. In contrast, the use of vermi-compost as bio-fertiliser has been increased from 450 metric ton in 2003-04 to 675 metric ton in 2005-06. Green manure is another common form of bio-fertiliser used in Koch Bihar district which shows slight increase of its use i.e., 30100 metric ton in 2003-04 to 30500 metric ton in 2005-06.

The agricultural implements used by the cultivators of the district are simple and not as efficient as the improved ones. It is observed that the farmers of the district have to share some of their agricultural implements with others which indicate that they do not possess the implements individually, but they borrow or lend on exchange basis. There is an urgent need to mechanise the agricultural operations so that wastage of labour force is avoided and farming is made convenient and efficient. However, despite progressive increase in the use of

agricultural implements, its sustainable benefits towards agricultural development have remained confined to the rich farmers.

Introduction of HYV seeds is one of the striking modernizations of agriculture in Koch Bihar district. It is only after 1981-82 that the cropping pattern underwent a distinct change with the introduction of short duration high yielding variety of paddy. The total area brought under HYV paddy crop by the end of 1980-81 was 114.22 thousand hectares which increased to 302.6 thousand hectares by the end of 2004-05 and the targets laid down since the introduction of these programmes were fully achieved.

Most of the farmers of the district are small and marginal farmers. In earlier times, *mahajan* (moneylender) was the chief source of money at a higher rate of interest to the farmers. Recently the situation is changing. Farmers are often used to borrow from co-operative societies or banks. There are 117 credit institutions which include four Central Co-operative banks, one Land Development bank, forty-six Regional Rural banks, sixty Commercial banks, one WBFC and one Jalpaiguri Central Co-operative bank in Koch Bihar district. The Central Govt. and the State Govt. both have taken some initiatives to provide agricultural credit to the farmers through said institutions.

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. Agricultural efficiency for the period 1980-81 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. On the other hand, 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. The impressive increase of agricultural efficiency is observed in Haldibari block which was the lowest in 1980-81 becomes the topmost by the year 2004-05.

The study reveals that during the study period, there is spatio-temporal variation in agricultural efficiency in the district. The study period shows that 11 blocks identified where agricultural efficiency for 20 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.

The growth trend analysis of major in terms of gross production by computing their compound growth rates present an interesting feature. The *aus* paddy production has shown a negative growth rate of 5.46%, indicates that its production witnessed declining trend in all the blocks of the district during the study period. In the case of *boro* production, the compound growth rate has increased by 24% per annum during the study period. As a whole, cereals recorded an increase of 2.14% per annum at district level.

The production of pulses has shown an annual increase of 0.08%. The food grains as well as food crops have shown an increasing trend in almost all the blocks except the block Mathabhanga II. The analysis with regard to production during the study period reveals an encouraging picture and it can be expected that this trend would continue in future also. Jute production in the district has recorded an annual growth rate of 0.58% during the study period. Potato production in the district has significantly increased during the study period at a compound growth rate of 15.58% per annum Production has increased in all the blocks of the district. Production of vegetables has increased at the compound growth rate of 9.05% per annum as a whole in the district. All blocks show positive growth rate in terms of production during the study period. 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 positive growth rates. 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.

Paddy as a whole shows significant growth in yield rate in the district during the period of 25 years. *Aus* paddy shows a marginal increase of 1.95%, the growth of *aman* paddy productivity has found lower than that of *aus* paddy i.e., 1.66% while negative growth of *boro* paddy of (-1.28%) has been observed in the district. Productivity of wheat in the district increased at a rate of 0.74% per annum. The productivity of jute in the district has found to increase by 1.14% per annum during the study period. In the 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. Productivity of pulses in Koch Bihar is declining trend and the compound growth assessed to be -0.26% per annum over the study period. 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. 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 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.

Crop ranking helps for understanding the geographical character of the area. Paddy occupies the dominant a real strength in the cropping pattern of the district. There were two crops, which occupied second ranking in the period I (1980-81), namely jute and tobacco while this number increased to three for the period II (2004-05) namely jute, tobacco and green vegetables. Four crops have been identified as the third ranking crops during 2004-05 namely wheat, jute, oilseeds, and vegetables. Other crops namely potato, wheat, pulses, tobacco, and spices have low percentage than that of paddy and jute.

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

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.

The spatial patterns of crop diversification have been grouped into the three major regions namely area of high crop diversification; area of moderate crop diversification and

area of low crop diversification. The study of crop diversification 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.

The agriculture of the district as a whole presents a shocking picture in the district's economy and is inter-woven by problems. Factors like, inadequacy of infrastructure, low productivity of various crops in comparison with state as well as national level, slowness of modernization and preponderance of traditionalism, excessive pressure of population, dependence on nature are the fundamental problems of agriculture in the district. It is urgently suggested that expanded and efficient supply of inputs and services, re-structuring of the cropping pattern, intensive cultivation, increased infrastructural facilities, minimising the ever-rising disparities and institutional interventions can suitably remove the existing loopholes in the agriculture of the district.