CHAPTER - II

PHYSICAL AND CULTURAL BACKGROUND OF THE STUDY AREA

2.0 Introduction

The present chapter deals with a detailed profile of Dinhata subdivision on all of its physical, social and agronomic characteristics. The main objective of this chapter is to study physical and cultural background of the study area. In effect, the physical and human environment of the study area are described using both the primary and secondary data. Maps have been prepared using ArcMap 10.3 software.

2.1 Physical background of the study area

2.1.1 Geology

The geological formation of Dinhata is from the Alluvium of present day formation to ancient times deposited *by Singimari, Dharala, Baniadah* rivers. A belt of alluvial detritus of the quaternary formations in the subdivision occurs just south of the Siwalik Group rocks. The formations are constituted of boulders, gravels, pebbles, sands and silts in the higher reaches forming alluvial fans and fluvial depositional terrace. In the lower reaches fluvial terraces of flood plain faces consisting mainly of sands, silts and clays are dominant. Seismic survey conducted by the Oil and Natural Gas Corporation of Govt. of India (2008-09) indicates that the basement of igneous and metamorphic rocks under Dinhata subdivision lies at depths between 1000 metres and 1500 metres and that the basement surface has a northerly slope.

The area is subdivided into a sequence of flood plains, the youngest being the present day flood plain represented by the present day channel deposit of the Jaldhaka and Torsa rivers besides minor creeks and gullies. Fluvial terraces of the older floodplain have generally a gradational contact. Of these, the lowest alluvial benches and depositional landform elements area in the process of formation and stabilization by lateral and vertical accretion processes. The older terraces covering the vast land of the study area occupy the elevated ground portions above the occasional and usual flood plain level. It is equivalent to Jalpaiguri and shaugaon surface.

Quaternary sediments that cover the entire subdivision constitute three morphostratigraphic units based on relative relief, state of compaction of sediments, degree of oxidation of the soil and degree of dissection the highest surface being the oldest followed, successively at lower elevations by younger surfaces. The three morphostratigraphic units that are hamessed by these surfaces in order of decreasing antiquity are: (a) Jalpaiguri formation. (b) Shaugaon formation and (c) present day flood plain deposits.

(a) **Jalpaiguri formation (Q2a):** The jalpaiguri formation occupy 30.71 percent (235.31 sq km) of the total area of Dinhata subdivision (Figure 2.1). This region incipient soil formation at the surface has an over burden of light grey silty loam underlain by unaltered multiple sequences of fine sand, silt and clay and bog clay at places in the flood basin . The surface is quite flat and replete with meander scars of aggraded streams, cutoff meander loops and remnants of older levees. During very high floods, pats of its surface are inundated. This zone is characterized by feebly oxidized incipient soil, surface flat with aggraded streams, cut off meander loops and older levees.Water logging due to high rainfall is however common.

(b) **Shaugoan formation (Q2h):** About 48.15 percent (368.3sq km) of the subdivision are under the Shaugaon formation, which is characterized by alternate rhythmic layers of sand, silt and clay, dynamic flood plain regime replete palaeochannels and flood basins, prone to water logging following high floods.The sediments are essentially unoxidised and unconsolidated except the clay horizons that are relatively compact .The sediments are course to fine grained and at places contain abundant mica flacks which impact variegated gray ,white and light gray tinge to these sediments.

(c) **Present day deposit (Q2p):** This region occupy only 11.66 percent (89.18 sq km) area of Dinhata subdivision (Table 2.1). The present day deposits are the materials of the present channel and stream system. These loose sediment show well developed lamination, cross bedding and ripple marks .The sediments are silvery grey to grey, coarse to fine grained highly micaceous sand and clay. The channel bars are often composed of layers of pebbles, coarse to fine grained sand and silt. This region is often characterized by loose unoxidised entisol, flood plain deposit annually, submerged by the rivers during monsoon.

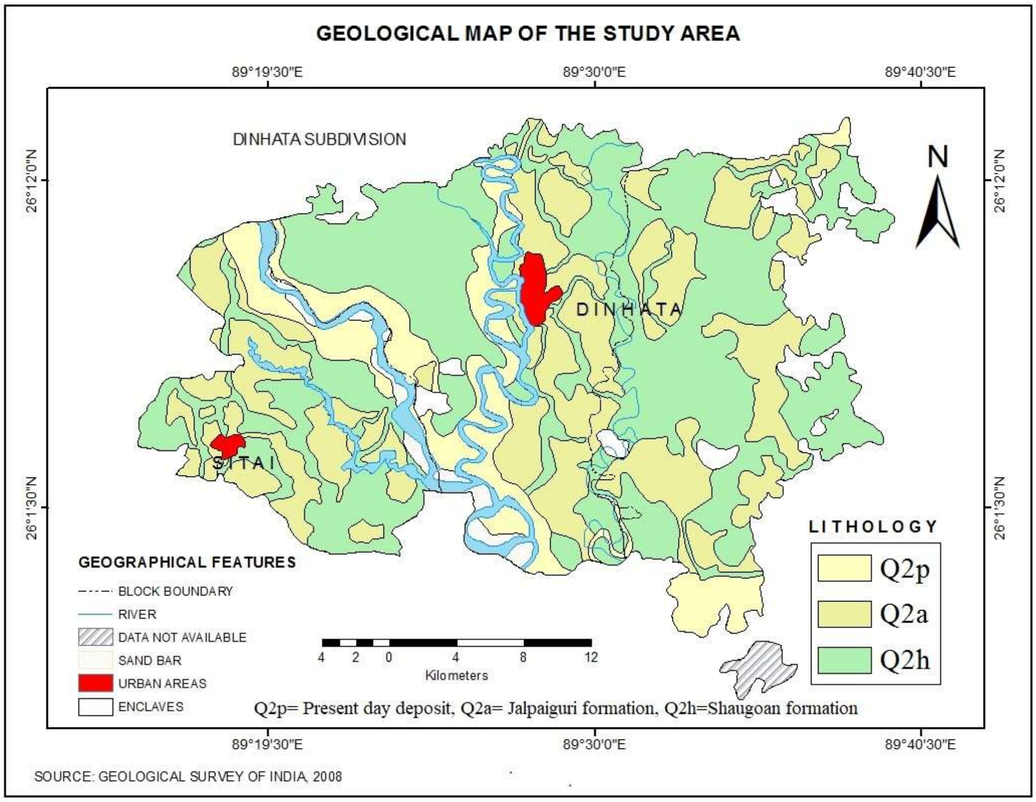


Figure: 2.1 Geological Formation

Table 2. 1 Geological Formation of the study area

Sl. No	Geological class	Lithology	Areas (sq km)	% of total area
1	Q 2a	Very fine sand, silt and clay	235.31	30.77
2	Q2h	Alternate layers of sand, silt and clay	368.3	48.15
3	Q2p	Light grey silty loam underlain by unaltered multiple sequences of fine sand, silt and clay with bog clay	89.183	11.66
4	Miscellaneous		72.046	9.42
Total			764.839	100

Source: Geological Survey of India, 2008

2.1.2 Topography

The entire area is essentially a flat country with minor undulation and low south easterly slope (Figure. 2.2). The rivers originating in the Himalayas to the north inundate the low lying areas during the monsoons while areas of marginally higher elevation remains above the water level even when the rivers area at spate. Highest altitude of the subdivision is 70 metre, and the lowest height is 4 metre, while the relative height is 66 metre. There are slights ups and down and while some areas are low and inundated by rivers during monsoon period, others are slightly higher and remains always, above water even when the rivers are in spate. There are no hilly tracts within the subdivision, the greater part of the subdivision is cultivated land is composed of green field studded with bamboo, plums and orchards. There is no forest worth mention, but tract of land consisting mostly of heavy grass and shrubs are seen at places mostly along the interfluves of the major rivers. A large network of river lets traverse the subdivision from the north-west to south east direction. Being very near to the foot hills the rivers often spill their banks after heavy shower in their catchment area.

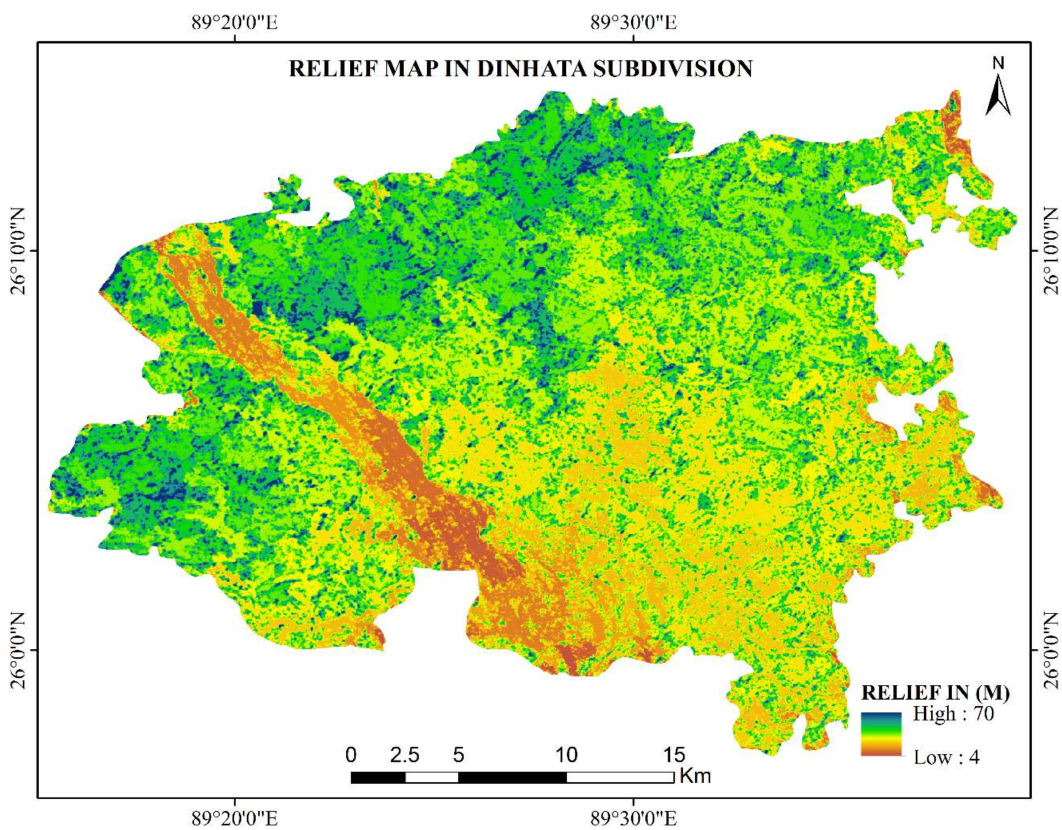


Figure: 2.2 Relief map in the study area

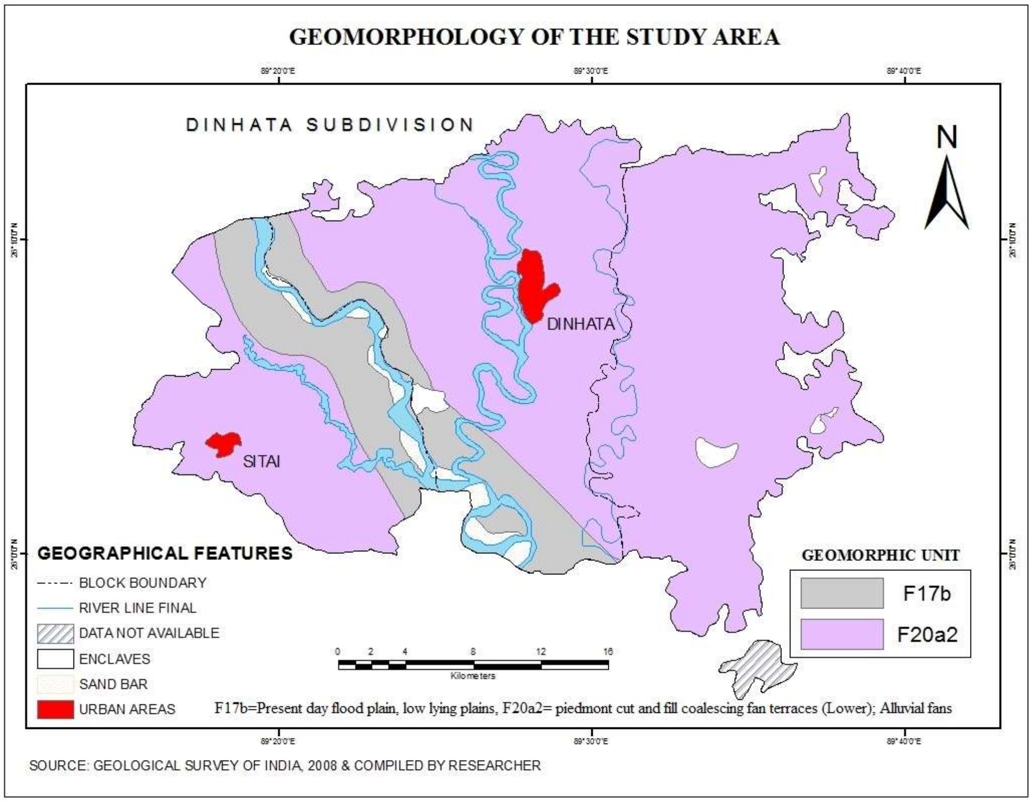


Figure: 2.3 Geomorphology of the Study area

Table 2.2 Geomorphology of the Study area

Geomorphology	Area (Sq km)	Percentage
F17b	98.46	12.87
F20a2	598.01	78.19
Miscellaneous	68.3733	8.94
Total	764.839	100

The study area is situated on the northern plain region, which is not far away from the Himalayan margin, for which different rivers with varied magnitude and intensity carry huge amount of detritus from different parts of the hills having varied geological, pedological and geomorphic origin and deposit all these materials in a diversified way after debouching on to the plain. Therefore the geomorphic characteristics of the alluvium (Figure 2.3) and the related pedological set-up of the Dinhata subdivision, reveals diversified pedological and geomorphic conditions over different parts of this region.

2.1.3 Climate

The agro-climatic condition of this subdivision is characterized as humid and damp throughout the year with high rainfall during pre-kharif (March to May) and Kharif season (June to September). Long term data of various climatic parameter such as minimum and maximum temperature, relative humidity, sunshine hours, rainfall and rainy days for 40 years (1972-2011) have been collected from meteorological station of Central Tobacco research Institute, regional research station, Dinhata, which is located at 26^0 20' N latitude and 89^0 27' E longitude and 41 metre above the mean sea level.

2.1.3.1 Temperature

Average monthly temperature was highest during August (28.28 ^{o}C) and lowest in January (15.43 ^{o}C). The mean annual temperature recorded was 23.18 ^{o}C. Mean (of 40 years) maximum and minimum temperature recorded were 32.93 ^{o}C (in August) and 7.49 ^{o}C (in January) respectively (Table: 2.3).The highest maximum temperature experienced was 36.60 ^{o}C (April 1993) and the lowest minimum temperature was 2.8 ^{o}C (January 1983). The cold weather prevails during December – February is obviously due to northeast monsoon. It could be observed from the data, the winter starts by December and carries on till February and this period is perfect for rabi crop cultivation in the study area. In rabi season, the mean maximum and minimum temperature was recorded 26.52 ^{o}C and 12.04 ^{o}C respectively. There is a little fall in maximum temperature in May owing to the cumulative effect of the heavy spell of summer rain associated with thunderstorms.

Table: 2. 3: Average monthly Climatic Parameter in Dinhata subdivision (1972-2011)

Month	Temperature (0^oC)			Relative Humidity (%)			Sunshine Hours
	Maximum	Minimum	Average	6:32 hrs	13:32 hrs	Average	H/day
January	23.37	7.49	15.43	89.82	59.44	74.63	7.0
February	25.45	9.61	17.53	87.86	54.95	71.41	8.0
March	29.85	13.74	21.80	84.55	51.05	67.80	7.6
April	31.55	18.07	24.81	84.33	59.55	71.94	7.0
May	30.98	20.49	25.74	86.68	69.70	78.19	6.6
June	31.61	22.42	27.02	88.77	75.00	81.89	4.8

July	31.22	23.30	27.26	89.27	78.00	83.64	4.1
August	32.93	23.63	28.28	88.88	75.05	81.97	5.3
September	31.31	22.33	26.82	89.90	76.21	83.06	4.8
October	30.55	19.53	25.04	88.02	70.01	79.02	7.3
November	28.23	14.21	21.22	85.64	60.62	73.13	8.4
December	24.99	9.34	17.17	88.25	58.26	73.26	7.8

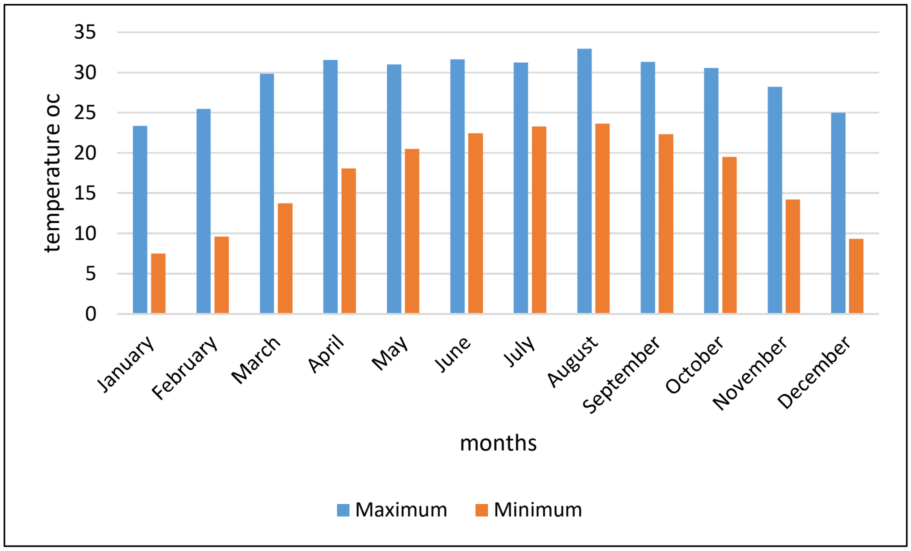


Figure: 2.4 Average monthly maximum and minimum temperature (1972-2011)

2.1.3.2 Relative Humidity

The average monthly humidity in the study area is 76.66 percent. It varies between 67.80 percent in March and 83.64 percent in July (Table: 2.3), whereas seasonal relative humidity varied from 72.64 in pre-kharif season to 82.64 in Kharif season (Table: 2.4). The study area experienced low humidity in the month of March and in pre-kharif season is due to onset of summer and its steadily increases in kharif season due to the effect of the south-west monsoon. In rabi season relative humidity (74.29 percent) again decreases as the area experience winter.

2.1.3.3 Sunshine Duration

Mean annual sunshine duration of the study area varied from 4.1 to 8.4 with an average of 6.6 ± 0.4 h day $^{-1}$ (Table: 2.3) and seasonal sunshine hours per day varied from 4.8 hours in kharif season to 7.7 hours in Rabi season (Table: 2.4) in this subdivision which is far below from that of other region of West Bengal or state average of West Bengal. This low duration of sunshine hours, cloudy weather running throughout maximum time during June to September, more infestation of pest and diseases on crops due to existence of cloudy weather altogether leads to significantly low productivity of different crops as compared to that in the subdivisions of South Bengal. Average period of bright sunshine hours per day in winter season (December to February) is also low which effect the productivity of rabi crops in this region. The generation of dew begins in the autumn, and continues throughout the spring.

Table: 2.4 Seasonal climatic parameter (1972-2011)

Season	Temperature (0^oC)			Relative Humidity (%)			Sunshine Hours
	Maximum	Minimum	Average	6:32 hrs	13:32 hrs	Average	H/day
Pre-Kharif	30.79	17.43	24.11	85.19	60.1	72.64	7.1
Kharif	31.77	22.92	27.34	89.21	76.07	82.64	4.8
Rabi	26.52	12.04	19.28	87.92	60.66	74.29	7.7
Annual	29.34	17.01	23.18	87.66	65.65	76.66	6.6

2.1.3.4 Rainfall

Analysis of annual and seasonal rainfall and rainy days variability

During the study period of 40 years (1972-2011), there were about 17.5 % of the years faced drought while, 15 % of the years faced excessive or flood and 67.5 % of the years had normal (Table.2.5). The mean annual rainfall of the subdivision was found to be 2909.88 mm. The Standard deviation and coefficient of variation was found to be 658.39 mm and 22.62 % respectively. The minimum annual rainfall of 1739.8 mm was recorded during the year 1994 and maximum of 4441.8 mm during the year 1984 over the study period. Hence, the annual rainfall showed high standard deviation and coefficient of variation (figure 2.7). The figure 2.6 showed that amount of annual rainfall decreased since last two decade except the years 1991, 1998,2005, 2008 and 2010 when rainfall was adequate .Out of past 40 years, 20 years recorded in excess of average rainfall and 20 years recorded as below normal rainfall.

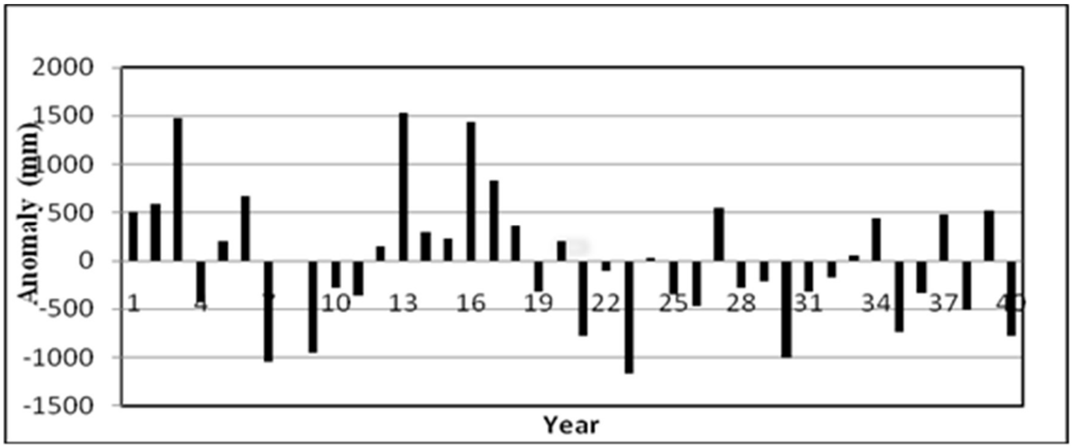


Figure: 2.5 Annual variability of rainfall over normal for the period of 1972-2011

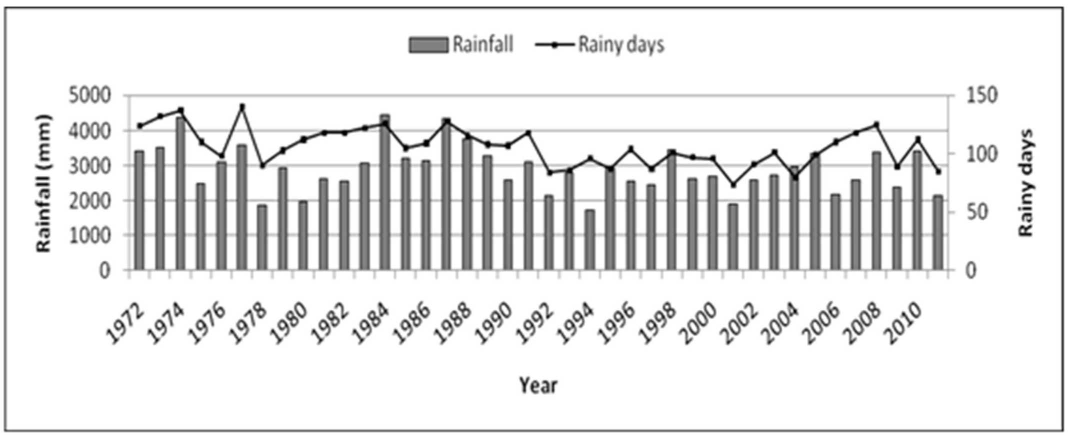


Figure: 2.6 Annual rainfall and rainy days during 1972-2011

Table: 2.5 Annual drought analysis for the period 1972-2011

Year	**Rainfall (mm)**	**Rainy days**	**Category**	**Year**	**Rainfall (mm)**	**Rainy days**	**Category**
1972	3428	124	N	**1994**	1739.8	96	D
1973	3504.1	132	E	**1995**	2933.1	87	N
1974	4388.8	137	E	**1996**	2565	104	N
1975	2487.2	110	N	**1997**	2440.1	87	N
1976	3111.8	98	N	**1998**	3465.3	101	N
1977	3581.1	140	E	**1999**	2631.7	97	N
1978	1859.6	90	D	**2000**	2691.5	96	N
1979	2916.6	103	N	**2001**	1904.5	74	D
1980	1956	112	D	**2002**	2586.1	91	N
1981	2628.2	118	N	**2003**	2739.6	101	N
1982	2543.4	118	N	**2004**	2970.4	80	N

1983	3059.4	122	N	**2005**	3360.6	99	N
1984	4441.8	126	E	**2006**	2179.9	110	D
1985	3210.7	105	N	**2007**	2579.3	118	N
1986	3135.4	109	N	**2008**	3393.2	125	N
1987	4341	128	E	**2009**	2396.5	89	N
1988	3745.6	116	E	**2010**	3429.9	112	N
1989	3268.5	108	N	**2011**	2140.2	85	D
1990	2587.4	107	N	**Mean**	2910.05	106	-
1991	3119.5	118	N	**SD**	658.39	16.1	-
1992	2140.6	84	D	**CV**	22.62	15.2	-
1993	2800.5	86	N	**R**	0.65	-	-
N= Normal, E= Excess, D= Drought							

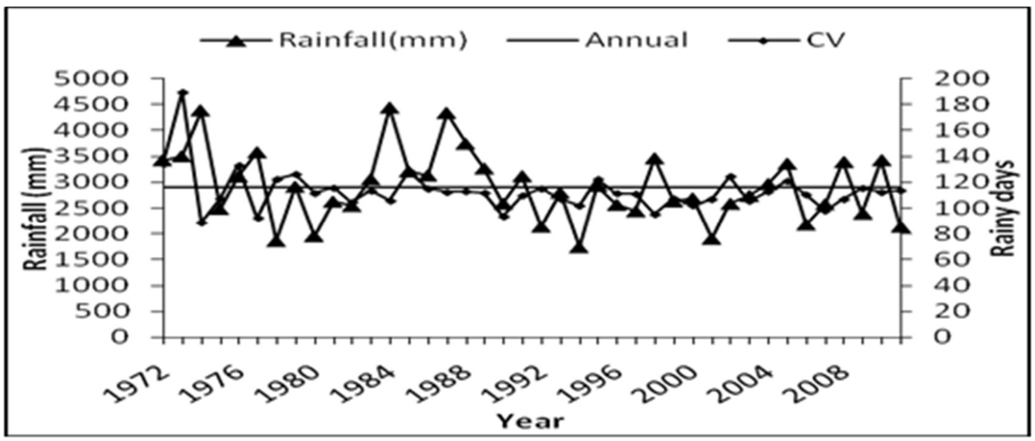


Figure: 2.7 Yearly variation in total rainfall and corresponding coefficient of variation

The average annual rainy days was 106.08 and standard deviation and coefficient of variation was found to be 16.11 days and 15.19 % respectively. The annual rainy days ranged from 74 days (the lowest during the year 2001) to 140 days (the highest during the year 1977). The coefficient of correlation between annual rainfall and rainy days (r=0.65) was highly positively related. Table 2.7 reveals that 1982-91 decade recorded highest average annual rainfall (3341.67 mm), while the lowest mean annual rainfall (2533.99) received during the decade 1992-01.During the 1st period, July was found to be the wettest month and June was the 2nd wettest month. But in next and recent decade June was shifted to the wettest month and July was the next wettest month, while during 1992-01 decade again July was found to be wettest month but August was 2nd wettest month. This shows there is highly erratic rainfall distribution due to breaks in monsoon or early onset/withdrawal of monsoon which may have impact on yield of kharif crops, cropping pattern and farming system in this region. Although, the rainfall distribution over the period was in no particular trend, however, the amount of rainfall decreased drastically for the month of August. The rate of decrease of rainfall in the month of August was 40.4 mm per decade. The highest rainfall was received during kharif season (2158 mm). The mean rainfall received during summer season was 535.86 mm and lowest in rabi season (215.39 mm). The percentage contribution of seasonal rainfall to the total was 74.18, 18.42 and 7.4 during *kharif*, summer and rabi season respectively.

Table: 2.6 Seasonal Rainfall variability

Season	Mean	Percentage	SD	CV
Summer	535.86	18.42	194.65	36.32
Monsoon	2158.6	74.18	556.14	3.44
Winter	215.39	7.4	133.63	62.04

Marked variation was observed in the seasonal rainfall pattern. It ranges between 1072.1 mm to 3555.8 mm in *kharif,* 262.9 mm and 1278.5 mm in summer and 23.4 mm to 601 mm in rabi season (Table 2.6). The lower value of coefficient of variation (3.44%) during *kharif* season depicted consistence occurrence of rainfall. However, the higher value of CV inferred that cultivation in rabi (62.04) and summer (36.32%) season can be practiced by depending on soil residual moisture or irrigation due to uncertainty of rainfall.

Table: 2.7 Decadal shift in rainfall pattern

Month	**1972-81**	**1982-91**	**1991-01**	**2002-11**
January	9.03	10.98	16.45	5.36
February	11.32	22.3	10.43	12.22
March	30.63	34.34	50.77	44.28
April	167.71	130.93	142.47	167.09
May	350.07	360.23	372.02	292.91
June	579.02	746.77	443.53	643.86
July	703.34	703.77	540.2	616.78
August	572.85	539.69	496.52	411.25

September	345.87	609.58	304.41	376.97
October	167.38	148.55	145.89	197.38
November	30.88	19.85	7.2	3.65
December	9.1	14.68	4.1	5.82
Annual	**2977.2**	**3341.67**	**2533.99**	**2777.57**

Analysis of monthly rainfall and rainy days variability

The average monthly rainfall gradually increased from January onwards and reached its peak (641.02 mm) in July, and then it decreased and it was lowest (8.42 mm) in the month of December (Table2.8). On the basis of long term data, July was the wettest month receiving rainfall 22.03 % of total amount followed by June (20.73%).

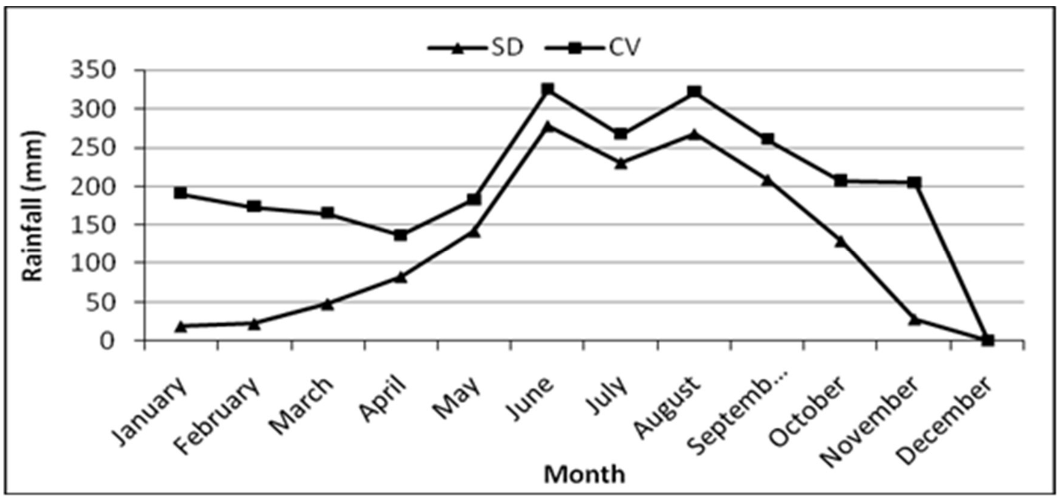


Figure: 2.8 Average monthly rainfall variability

On the other hand, December was the driest month receiving only 0.29 % of total amount of rainfall followed by January (0.36%). However, very high coefficient of variation in the months of November to March indicating that cultivation of rabi crops without irrigation is highly risk.

The analysis of average monthly days revealed that it also increased gradually January up to the month of July (19.65 days), which thereafter decreased and it was minimum (0.7 day) in the month of December. The months May to September experienced an average of more than 15 rainy days. But from the month of November to February the average rainy days less than 2, which indicate these months experienced drought.

Table: 2.8 Monthly variability of rainfall in Dinhata subdivision

Month	Mean	Percent	SD	CV	Mean+SD	Mean-SD
January	10.46	0.36	18.04	172.55	28.5	-7.58
February	14.07	0.48	21.37	151.91	35.44	-7.3
March	40.01	1.37	47.06	117.64	87.07	-7.05
April	152.05	5.23	82.12	54.01	234.17	69.93
May	343.81	11.82	141.42	41.13	485.23	202.39
June	603.3	20.73	278.65	46.19	881.95	324.65
July	641.02	22.03	230.72	35.99	871.74	410.3
August	505.08	17.36	268.13	53.09	773.21	236.95
September	409.21	14.06	208.84	51.04	618.05	200.37
October	167.05	5.74	129.26	77.38	296.31	37.79
November	15.4	0.53	27.29	177.27	42.69	-11.89
December	8.42	0.29	0	0	8.42	8.42
Annual	**2909.88**	**100**	**658.39**	**22.62**	**3568.27**	**2251.49**

Analysis of weekly rainfall and rainy days variability

Marked variations were observed in weekly rainfall over the forty year time period. Mean weekly rainfall was maximum (147.86 mm) in 30th SMW followed by 26th SMW (146.21 mm) and 33rd SMW (146.16 mm).The average rainfall ranges from 0.07 mm (14th SMW) to 147.86 mm (30th SMW).The average weekly rainfall during the monsoon season (22nd to 40th SMW) was found to be higher than other seasons varying from 68.03 mm to 112.79 mm (figure 2.9).

These rainfall accounts are sufficient for growing *kharif* crops in this region. But the high intensity or abnormal rainfall storms during southwest monsoon season causes flash flood, which adversely affects the lowland crops. The coefficient of variation ranges from 1.21% (33rd SMW) to 2157.14 (51st SMW). Weekly rainfall variation in monsoon season varied between 1.21% and 2.43% indicated more or less stable rainfall during the monsoon, where as in rabi season CV varies from 4.47% to 2157.14% and in summer season it ranges between 2.73% and 73.56%.

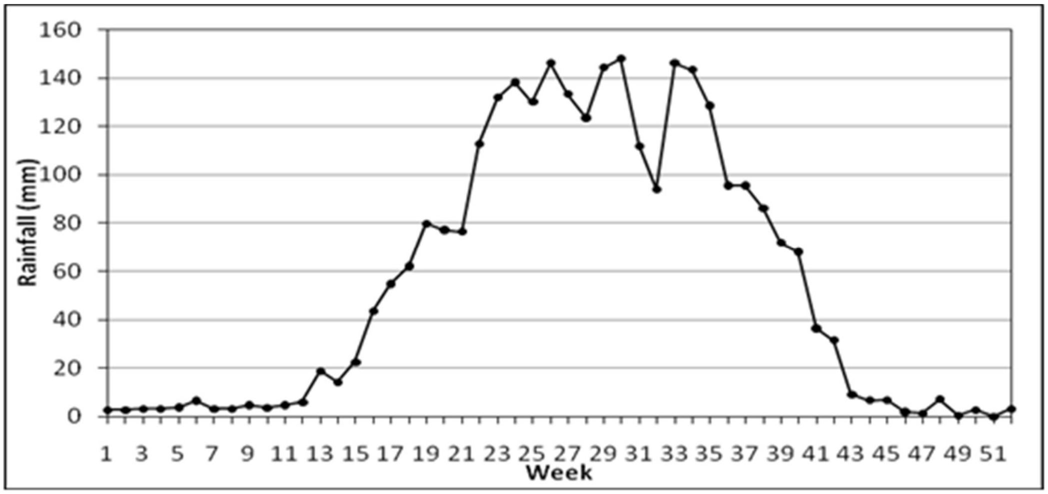


Figure: 2.9 Average weekly rainfall in Dinhata subdivision (1972-2011)

The average weekly rainy days show that it increased from first week and reached maximum (4.48 days) in 29th SMW, which thereafter decreased as a curvilinear trend. However, during the period of study 7.69% of week had no rain or rainfall <2.5 mm. Result reveals that 21.15% of the weeks had more than 4 rainy days and 34.62% of the week had 1 to 3 rainy days, whereas rest of the weeks 65.38% experienced <1 rainy day.

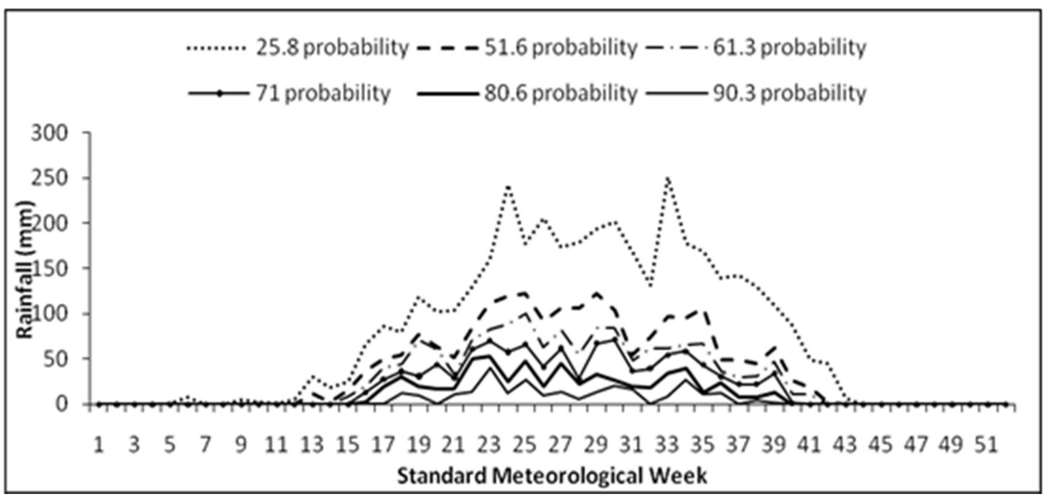


Figure: 2.10. Variation of weekly rainfall at different probability level

Probability of Rainfall and rainy days

The past 40 years rainfall data have been analyzed and its weekly, monthly, annual, and season wise (Kharif or monsoon, rabi or winter and summer) probability occurrence was predicted (Table 2.9). This prediction helps to optimize choice of crops, sowing date, and irrigation scheduling for different crops cultivated in this region (Jakhar et al., 2011).Result presented in Table 2.9 reveals that the probability of occurrence of rainfall at 75.64% chance is 1782.8 mm in khaif season, 403.2 mm in summer and 102.8 mm in rabi season while at 51.2%, 61%, 71%, 80.5%, and 90.3% chance the expected total

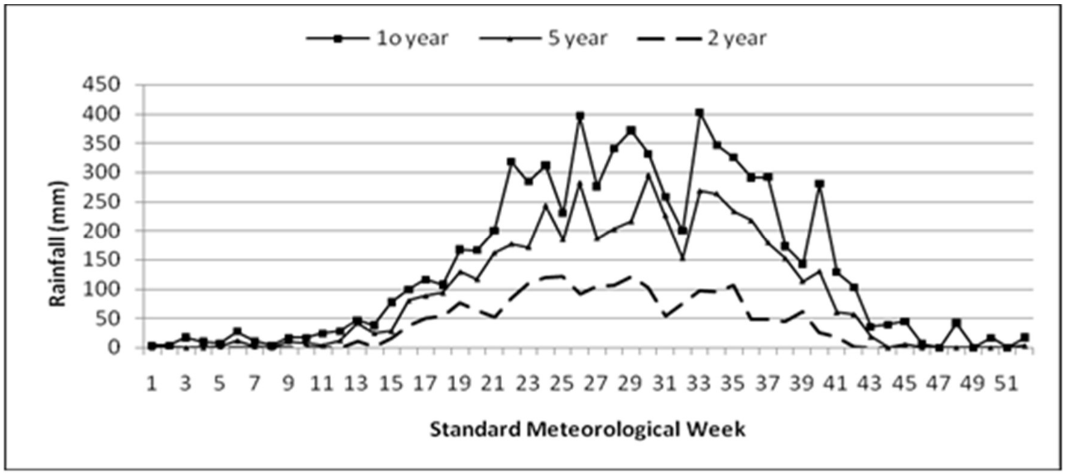


Figure: 2.11 Weekly expected rainfall occurrence at different recurrence intervals

annual rainfall is 2800.5 mm, 2628.2 mm, 2565 mm, 2396.5 mm, and

Table: 2.9 Weekly expected rainfall occurrence at different recurrence intervals

			Rainfall				Rainy days			
Rank	**T**	**P**	**M**	**S**	**W**	**A**	**M**	**S**	**W**	**A**
1	41	2.44	3555.8	1278.5	601	4441.8	88	42	19	140
2	20	4.88	3261.4	921.2	507.7	4388.8	87	42	18	137
3	14	7.32	3095.2	906.8	458.9	4341	82	39	18	132
4	10	9.76	2902.3	834.3	419.1	3745.6	81	38	17	128
5	8	12.2	2816.4	715.9	411.3	3581.1	81	37	15	126
6	7	14.64	2619.5	674.7	370	3504.1	81	36	15	125
7	6	17.08	2567.4	664.6	342.3	3465.3	79	35	15	124
8	5	19.52	2566.2	634.1	306	3429.9	79	35	15	122
9	5	21.96	2565.1	620.8	296.7	3428	79	32	15	118
10	4	24.4	2559.8	609.6	271.2	3393.2	77	32	13	118
11	4	26.84	2533.7	607.3	271.2	3360.6	76	32	13	118
12	3	29.28	2518.1	594.5	271	3268.5	76	32	12	118
13	3	31.72	2514.5	587.9	270	3210.7	75	31	12	116
14	3	34.16	2460.3	581.6	265.1	3135.4	74	30	12	112
15	3	36.6	2447.1	569.4	257.2	3119.5	73	30	12	112

16	3	39.04	2442.7	557.4	250.1	3111.8	72	28	11	110
17	2	41.48	2441	555.8	237.6	3059.4	72	28	11	110
18	2	43.92	2346	528	233.7	2970.4	72	28	11	109
19	2	46.36	2211.3	514	204.8	2933.1	72	27	11	108
20	2	48.8	2136.4	514	188.5	2916.6	72	27	11	107
21	2	51.24	1966	499.1	182	2800.5	69	25	10	105
22	2	53.68	1937.3	483.3	178.3	2739.6	69	25	10	104
23	2	56.12	1937.2	481.6	172.4	2691.5	67	25	10	103
24	2	58.56	1933	477.2	167.6	2631.7	66	25	10	101
25	2	61	1902.8	472.5	161.7	2628.2	66	24	9	101
26	2	63.44	1899.5	460.8	133.8	2587.4	64	24	9	99
27	1	65.88	1859.9	438.4	130	2586.1	63	24	9	98
28	1	68.32	1818.3	437.2	129	2579.3	63	23	9	97
29	1	70.76	1804	420.6	110.3	2565	61	23	9	96
30	1	73.2	1803.6	417.3	103	2543.4	59	23	8	96
31	1	75.64	1782.8	403.2	102.8	2487.2	58	23	7	91
32	1	78.08	1719.2	397.6	93.6	2440.1	57	23	7	90
33	1	80.52	1687.6	386.6	89.8	2396.5	56	23	7	89
34	1	82.96	1662.4	363.6	80.6	2179.9	55	22	7	87
35	1	85.4	1578	344.7	79.7	2140.6	53	22	6	87
36	1	87.84	1449.8	324.4	68	2140.2	53	20	6	86
37	1	90.28	1375.4	319.2	65.8	1956	52	19	6	85
38	1	92.72	1345	287.7	61.6	1904.5	51	19	6	84
39	1	95.16	1250	286.2	48.9	1859.6	51	16	5	80
40	1	97.6	1072.1	262.9	23.4	1739.8	40	16	3	74
M=Monsoon, S=Summer, W= Winter, A=Annual										

1956 mm, respectively. Similarly at 75.64% probability level occurrence of rainy days per year is 91, 58 days in kharif 23 days in summer and 7 days in rabi season. The figure 2.11 reveals that at 71 % chance, no rainfall is expected in every year during 1st to 15th and 41st to 52nd SMW, whereas an appreciable amount of rainfall is available during 18th to 36th SMW and maximum rainfall of 70.8 mm is expected during 30th SMW. At 71% probability, the expected weekly rainfall varied from 1.6 mm to 70.8 during 16th to 40th

SMW. In kharif, good weekly rainfall (>15 mm) started from 17 SMW with 80.6% probability, when primary tillage operation may be initiated.

Rainfall analysis further revealed increasing trend at all probability level during 21st to36th SMW. This indicates that preparation of seed bed and sowing of *kharif* crops may be performed during 21st SMW. The effective monsoon continues in the region for next 15th SMW. It is reveals from the Figure 2.11 that more than 10 mm rainfall is expected at 2 years recurrence interval between 13th to 41st SMW, 5 years recurrence interval <10 mm rainfall is expected between 12th to 43rd and 10 year interval reveals that <10 mm rainfall is expected between most of the SMW. Hence, kharif crop planning can be designed on the basis of 2 years recurrence interval but rabi cultivations are not possible without irrigation facilities.

Relation between rainfall and rainy days

The positive correlation between long term average annual rainfall and rainy days is observed, which is significant at 1% probability level (r=0.65), indicates that increasing rainy days also increasing the amount of rainfall in this region, similar relation were found for weekly, monthly and seasonal basis data. Although, it was observed that the rainfall was higher than the normal in 1976 (201.91), 1995 (23.05 mm), 1998 (555.25 mm), 2004 (60.35 mm), and 2005 (450.55), whereas rainy days in those year were decreased by 8.08, 19.08, 5.08, 26.08, and 7.08 days respectively indicating occurrence of flashed flood during those year. Conversely, rainy days were increased than the normal in 1975 (3.92 days), 1980 (5.92 days), 1981 (11.92 days), 1982 (11.92 days), and 2006

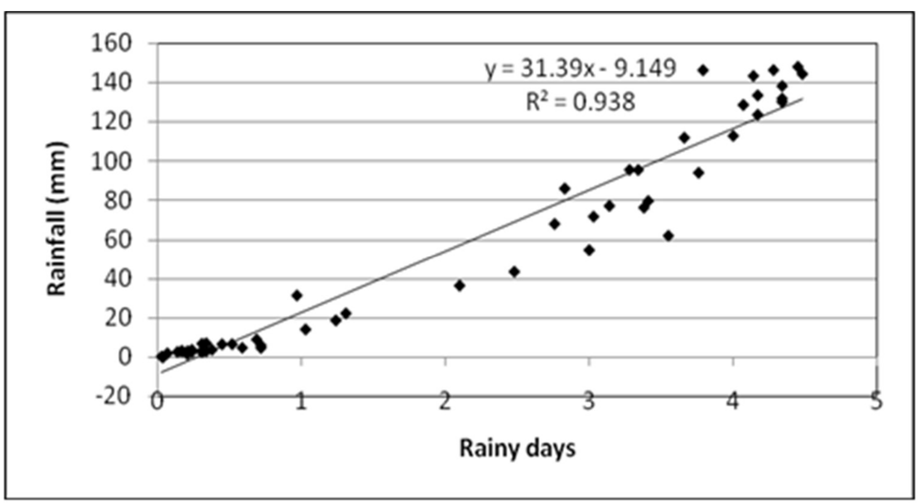


Figure: 2.12 Relationship between rainfall and rainy days

(3.92 days) but rainfall decreased by 422.85 mm, 954.05 mm, 281.85 mm, 366.65 mm and 730.15 mm. This caused severe drought in those year. The regression equation ($y=31.39x -9.149$) developed between the variables of rainfall (y) and rainy days (x) can explain more than 93% of the variability ($R^2 = 0.938$) (figure 2.12). Similar finding were reported by Dabral (1996), Chakraborty and Mandal (2008), Jakhar *et.al*. (2011).

This region has a brief spell of summer which in fact sandwiched between the spells of rainy season from May to July and mid-September to October. Pre- monsoon rainfall starts from 1 fortnight of March which facilitates the early sowing of Jute and it continues up to middle of October, because of which rabi cultivation is delayed in each year. Moreover, the distribution of rainfall throughout the year is not uniform, major percentage of rainfall occurs generally in between June to September. But in recent years, a significant decrease in rainfall is being noticed during last week of July to last week of August which results scarcity of water in transplanted Aman paddy and creates problem in retting of Jute. On the other hand, a considerable portion of major share of rainfall occurs during June-July (up to 3rd week) and last week of August to September. For this reason, 2nd week of July and last week of September are considered as two most vulnerable time for flood. And due to occurrence of flood or flood like situation after a long dry spell during August, outbreak of Swarming Caterpillar on Aman paddy is a common phenomenon of this subdivision.

Winter in Dinhata subdivision broadly coincides with the Rabi season when a large number of crops of all major groups are cultivated taking the advantage of the weather characteristic of the season. Important among these are tobacco, wheat, Boro paddy, mustard, potato, pulses, winter vegetables and maize. Most of the crops of the season are very much weather-sensitive. The spell of bad weather characterised by cloudy sky, light to moderate rain, high humidity and fog, large fluctuation of temperature etc. have considerable adverse impact on almost all standing crops of the season. This uncongenial spells of weather, associated with the passage of the western disturbances, hamper the normal growth and development of the crops on one hand and promote the occurrence of pests and diseases on the other, resulting in huge crop loss. Another weather hazard during tobacco crop period in this study area is thick clouds which suddenly appeared in the afternoon followed by severe storm, rain and hailstones which badly damaged the tobacco crop which is a common phenomenon as reported by the respondents.

2.1.4 Drainage

The subdivision has network of perennial river and ephemeral stream. The main river of the study area are Dharala, Singimari, Baniadaha, Kaljani, Gidari and Maldaha. These rivers flow in slanting course from northwest to south-east (figure 2.13). All of them take rise in the Himalayas and enter the Cooch Behar district from the western Duars of the district of Jalpaiguri. Flowing through the subdivision they pass on the Rangpur district of Bangladesh to discharge their waters into the Brahmaputtra. The banks of the river are abrupt and the beds are sandy. There is generally a beach on one side through at places both banks are abrupt. The bed is sandy and sands shift at the time of the monsoon when the rivers are in spate, trees which fall down owing to erosion of the soil on which they were rooted are carried along in the torrential current and pose a severe danger to the terries over such rivers.

The rivers in the dry season are tame and with exception of the Singimari mostly shallow. But due to the vicinity of the Himalayas, in which they rise, even an ordinary rainfall on the hills causes a sudden rise of these rivers which overflow the banks and the gushing water destroy crops and even homesteads. Through generally the rivers keep to their beds small oscillation and throwing out of a channel are almost annual features of these rivers. Just as the water of these rivers suddenly. So also the fall is quickly. The flooding water hardly remains on the fields for more than a day or two in ordinary inundation. The soil through which the rivers flow being alluvium of very recent origin.

Floods are the majored environmental hazards of the area during the monsoon because of heavy local rainfall discharge of upper basin areas and outfall condition in the neighbouring countries. The rivers; as a result broadened and cause bank erosion. In the floodplains, the rivers are silt charged. Silt deposition tends to increase the width of the river. The curvature of the channel within the present day flood plain determines the erosional and depositional banks. Devastation of vast tracts of land, villages, affecting bridges, railway lines roads and buildings, is a recurring problems river bank erosion due to meandering of rivers is presently the main predicament of Dinhata subdivision. Of the large numbers of abandoned channels, some connect with the present rivers during the monsoon .The depressed portions in the adjoining areas remain water logged for considerable periods causing loss in the landed property and disruption in communications of the area .

Singimari River

Means of transport

New constructed bridge at Gosanimari

Plate: 2.1 Singimari River near Gosanimari

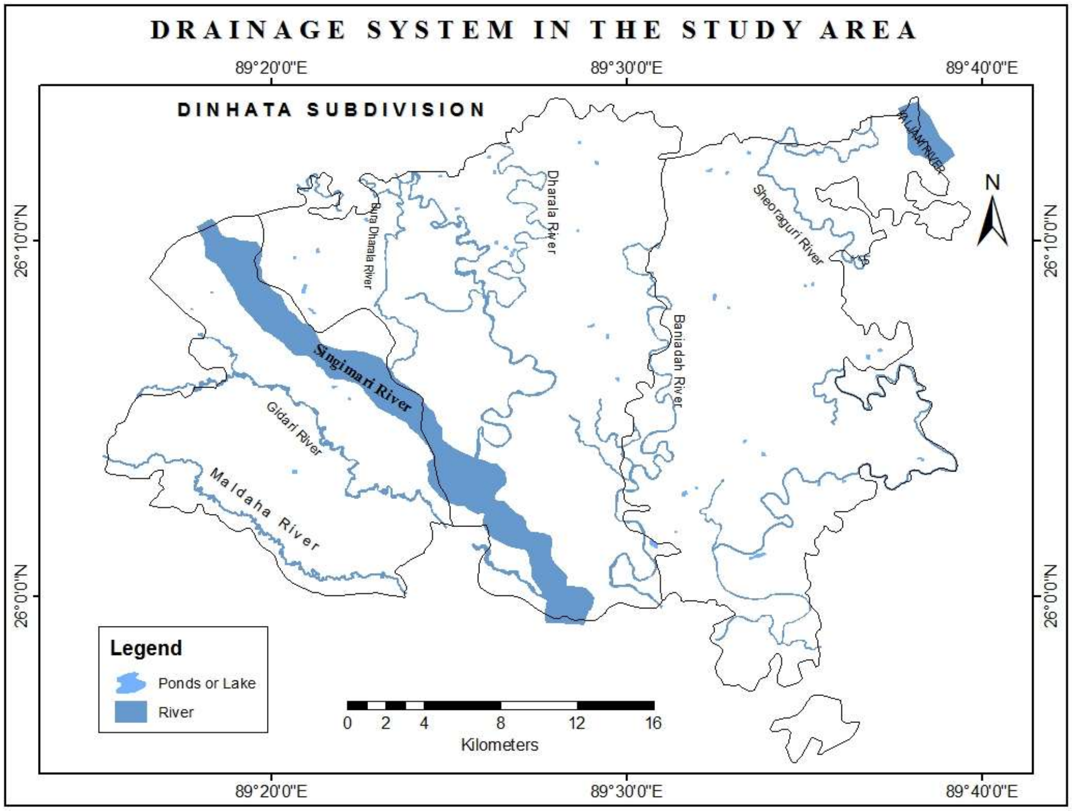


Figure. 2.13 Drainage system of the Study area

2.1.5 Ground water

Ground water in the study area is good and potable for both agricultural and domestic purposes as the concentration of chemical constituents are within the permissible limit except for high Fe-contents in localized pockets. The water is feebly acidic to marginally alkaline, the pH varies from 6.5 to 7.8, the bicarbonate contents vary from 20 to 510 ppm, Iron content generally varies from 0.04 to 10.2 ppm, and fluoride content varies from 0.12 to 0.37 ppm and as such does not create any health hazard. The specific conductance of water varies from 66 to 599 micro ohms / cm at 25^{o}c. Ground water in the district occurs under both water table and confines conditions in aquifers ranging in depth from about 2 m 303 m b.g.l. Dug wells and medium to heavy duty irrigation tube wells are in use to tab the ground water. They vary in depth from about 2 m to 8 m b.g.l.; the majority of them have a depth of 4.6 m b.g.l. The depth to water level varies with the topography and become steeper towards the northern side; ranging from 1.17 m to 6.70 m b.g.l. The maximum depth of water level is about 2.5 m from monsoon to summer.

The water bearing layers in the study area which constitute assorted boulders, pebbles, gravels and coarse to medium grained sand with occasional pockets of clay, are very permeable and transmissive. Transmissivity of sand layers very from 957.37 to 13,997.34 m^3 /d, the coefficient of field permeability varies from 2641 to 338 m^3/d. Heavy duty irrigation tube wells yield up to about 220 m^3/d. Medium duty irrigation tube wells generally yield about 22.7 to 45 m^3/d while the dug wells tapping the shallow aquifers can normally yield up to 500 m^3/d.

The ground water potential available in the study area for irrigation is about 423.55 MCM while the ground water balance available for further development is 530.70 MCM. In Dinhata-I block ground water balance of 416.00 MCM available for further development and in Sitai block has balance of 114.70 MCM.

2.1.6 Vegetation cover

The greater portion of the subdivision is well cultivated, composed of green field studded with bamboo clumps and orchards, which surround the homestead of every substantial farmer. The major flora here includes among others palms, bamboos, creepers, ferns, orchids, aquatic plants, fungi, timber, grass, vegetable and fruit trees. Patches of

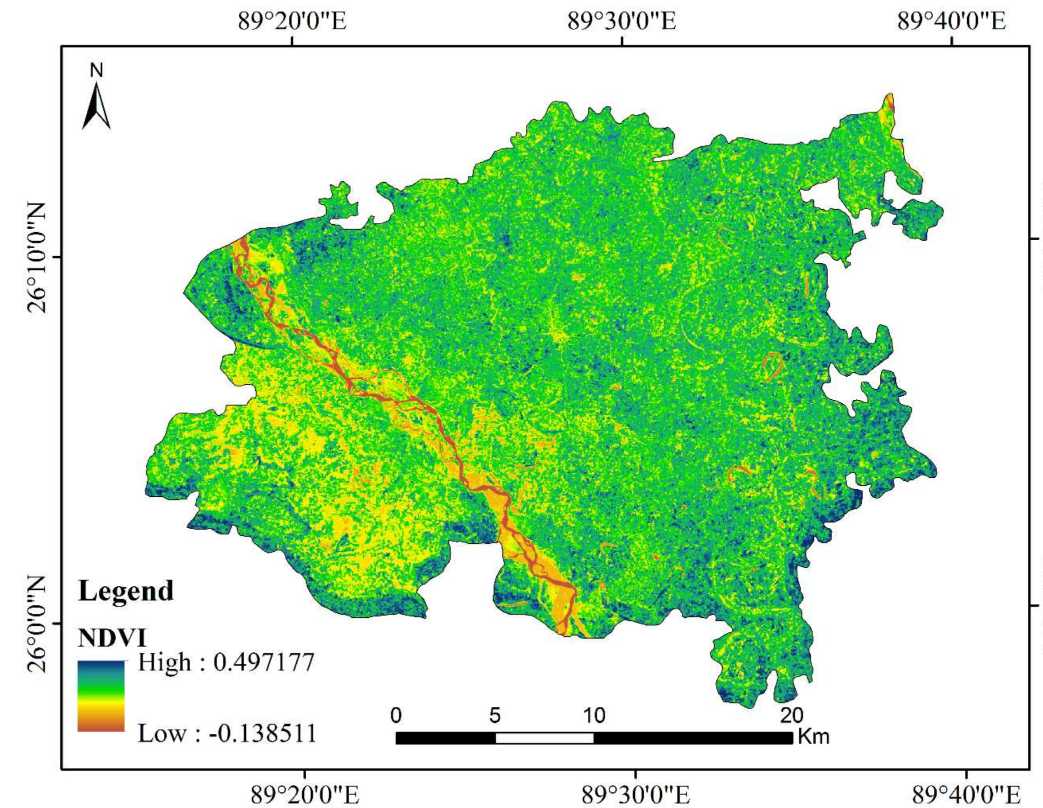
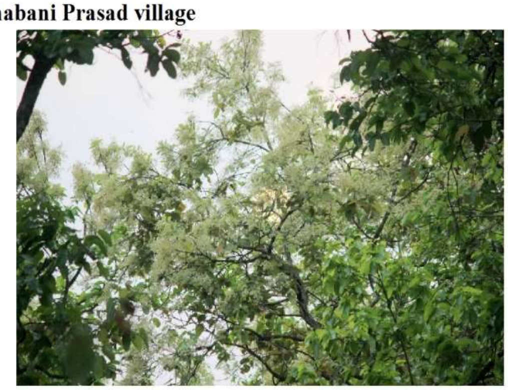


Figure: 2.14 Vegetation cover of the Study are


Forest:Gosanimari


Marshy Land in Bhabani Prasad village

Bill near Sitai hat



Social forestry at Nayarhat school

Agro-Forestry

Plate: 2.2 Vegetation and wetland in the study area

brushwood are, however, to be met with in almost every part of the subdivision. In absence of notified forest area in the subdivision; only a small area in Gosanimari, and a few other patches of land here and there, have clusters of Sal trees on them, not many species of animal are found though there are many wildlife sanctuaries, national parks and animal reserves in the neighbouring Jalpaiguri district and Alipurduar district which are not very far from the study area.

In 1976 Koch Behar district became home to the Jaldapara Wildlife Sanctuary (now Jaldapara National Park), which has an area of 217 km^2 (83.8 sq mi) (District profile, Cooch Behar). In Dinhata-I block, there are only 52.52 hectare of forest area along the Singimari river, which spread in Khalisa gosanimari, Jambari, Phulbari, Paharganj and Chakiarpara Dwitiyakhand. The subdivision consists of 48.89 hactare of social forestry, among which 26.21 hactare in Dinhata-I and 22.68 hactare in Sitai block, which maintained by the respective panchayet samiti.

2.2 Cultural background of the study area

2.2.1 Socio-economic Characteristics of the study area

2.2.1.1 Density of Population

Population density of the study area is highly related to the physical environment such as relief, flood prone area, wetland, river; economic activity such as agriculture, market, transport network, and social conditions. According to 2011census, density of population of Dinhata subdivision was 978 persons per sq km. It is high compare with density of the district average (832 persons per sq km). Density of population of Dinhata-I, Dinhata-II and Sitai block were1134 persons per sq km, 988 persons per sq km and 686 persons per sq km respectively (Figure 2.15). The highest density of population is observed in and around the

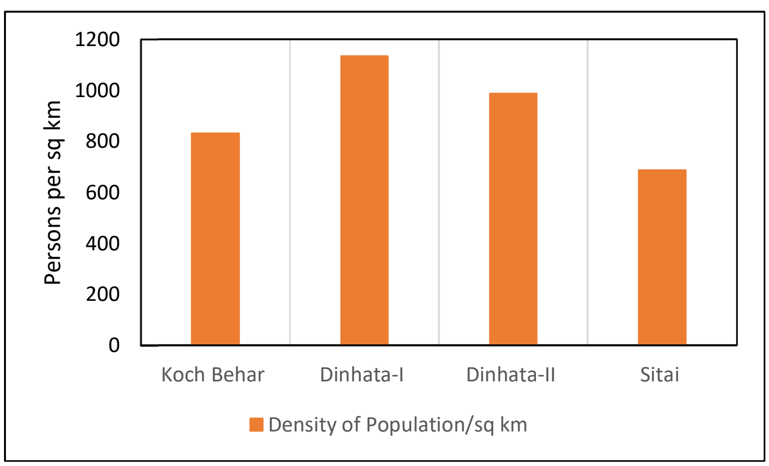


Figure: 2.15 Comparison of Population density

Dinhata town and lowest density observed along the International border area.

2.2.1.2 Distribution of population

As per 2011 census of India, Dinhata subdivision had a population 676792 out of which 348625 were males and 328167 were females. In Dinhata-I CD block had a population of 322393, out of which 165946 males and 156447 females. Scheduled castes numbered 125873 and scheduled tribes numbered 1171. In Dinhata-II CD block had a population of 244066 persons. There were 122663 males and 117403 femalles. Scheduled castes numbered 106859 and scheduled tribes numbered 1237. Whereas Sitai CD block had a population of 110333, out of which 56016 males and 54317 females. Scheduled castes numbered 72924 and scheduled tribes numbered 215 (Appendix-B).

2.2.1.3 Literacy

As per 2011 census, about 72.27 percent of population was literate, which is low compared to state and district literacy rate (literacy rate of West Bengal 76.26% and Koch Behar 74.78 %). Very low literacy rate was found in Sitai block (62.79%). For college studies, people of the study area is highly depends on Dinhata college and nearby Sitalkuchi, Mathabhanga and Cooch Behar college, while for higher studies depends on Panchanan Barma University and Uttarbanga Krishi Biswavidyalaya, are located near the study area but outside of the subdivision.

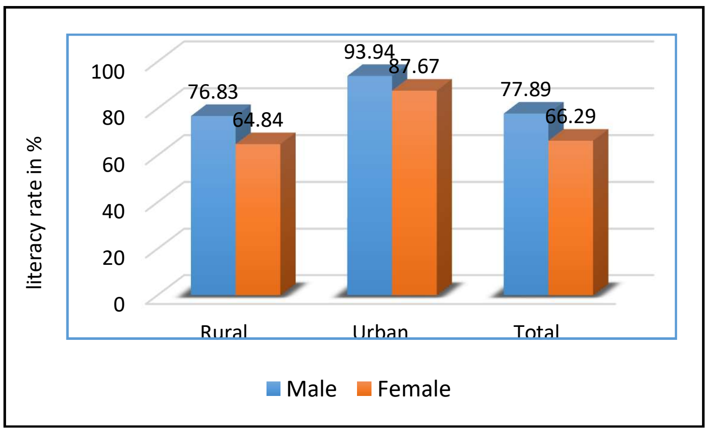


Figure: 2.16 Literacy rate

Table: 2.10 Literacy rate by sex in rural and urban areas in Dinhata Subdivision-2011

Sub-Division / C.D.Block / M	Rural			Urban			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Dinhata-I	78.62	67.12	73.05	89.09	79.44	84.44	78.79	67.31	73.23

Dinhata(M)	-	-	-	94.53	88.62	91.61	94.53	88.62	91.61
Dinhata-II	78.09	66.10	72.33	-	-	-	78.09	66.10	72.33
Sitai	69.17	56.21	62.79	-	-	-	69.17	56.21	62.79
Dinhata Subdivision	**76.83**	**64.84**	**71.02**	**93.94**	**87.67**	**90.85**	**77.89**	**66.29**	**72.27**

Source: Statistical Handbook,2013

2.2.1.4 Occupational structure

Agriculture is the mainstay of life of the people of the study area, and hence a major portion of the population is depends on agriculture. The total population of Dinhata subdivision is 676792 of which 40.37 percent are working population, out of which 32.15 percent main worker and 8.22 percent marginal worker (Table 2.11).

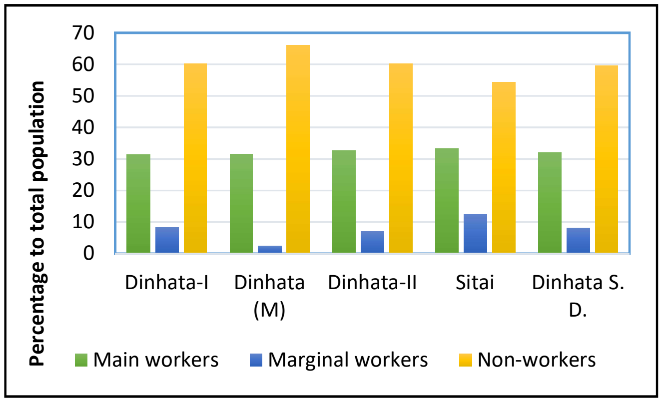


Figure: 2.17 Distribution of worker and non worker

Table: 2.11 Distribution of worker and non-worker in Dinhata Subdivision-2011

Sub-Division / C.D.Block / M	Main workers		Marginal workers		Non-workers		Total Population
	Number	P.C.	Number	P.C.	Number	P.C.	
Dinhata-I	89784	31.36	23949	8.37	172536	60.27	286269
Dinhata (M)	11377	31.49	870	2.41	23877	66.10	36124
Dinhata-II	79695	32.65	17182	7.04	147189	60.31	244066
Sitai	36764	33.32	13623	12.35	59946	54.33	110333
Dinhata S. D.	**217620**	**32.15**	**55624**	**8.22**	**403548**	**59.63**	**676792**

Source: Statistical Handbook, Cooch Behar

The total working population is 273244 in which 75.06 percent are both cultivators and agricultural labourer (Figure 2.18).

Table: 2.12 Distribution of population over different categories of worker in Dinhata Subdivision-2011

Sub-Division / C.D.Block / M	Total Workers(TW)		Class of Total Workers							
			Cultivators		Agricultural Labourers		Household Ind. Workers		Other Workers	
	Number	P.C.	Number	PC to TW	Number	PC to TW	Number	PC to TW	Number	PC to TW
Dinhata-I	113733	39.73	34673	30.49	44440	39.07	4145	3.64	30475	26.80
Dinhata (M)	12247	33.90	83	0.68	199	1.62	279	2.28	11686	95.42
Dinhata-II	96877	39.69	32463	33.51	49468	51.06	1294	1.34	13652	14.09
Sitai	50387	45.67	21141	41.96	22635	44.92	843	1.67	5768	11.45
Dinhata S. D.	**273244**	**40.37**	**88360**	**32.34**	**116742**	**42.72**	**6561**	**2.40**	**61581**	**22.54**

Source: Statistical Handbook, Cooch Behar

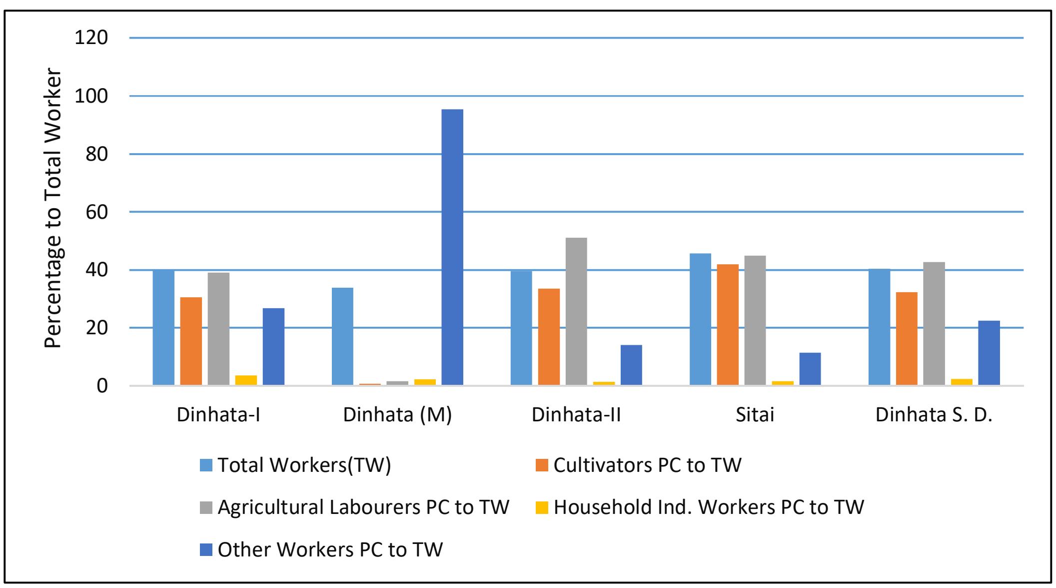


Figure: 2.18 Occupational structure of the study area

2.2.1.5 Transport

Transport network plays an important role in the agricultural development. The study area is well connected through metalled and unmetalled roads (Figure.2.19). Dinhata town is connected by railway line and there are railways from New Cooch Behar to Bamanhat through Dinhata. A major road connects Dinhata- Cooch Behar- Siliguri.

The state owned North Bengal state transport corporation buses and private buses operte on the main roads.Floods occurs almost every year. They cause lots of damage to existing roads and bridges every monsoon. Some of the village of the study area are still inaccessible during monsoon periods. Singimari the renowned river of the study are bisects the two blocks and there is practically still no communication between Dinhata and Sitai. Ferry services are available at Adabari ghat.

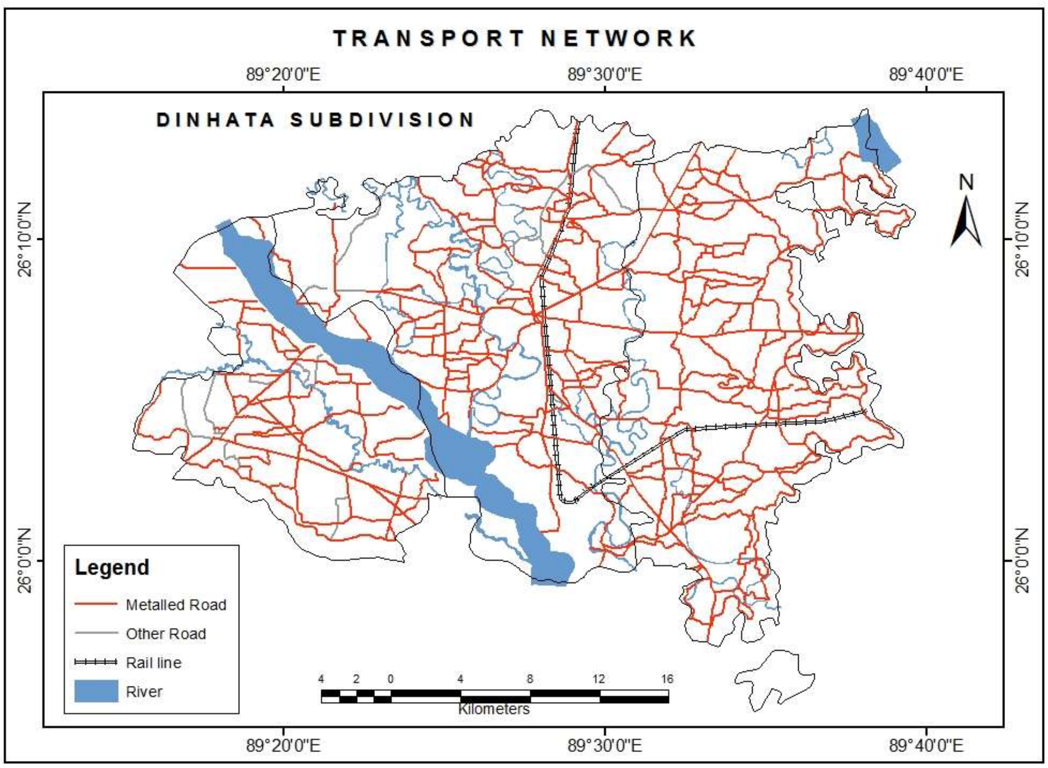


Figure: 2.19 Transport Network the Study area

2.2.2 Agro-economic characteristics of the selected farm

2.2.1.1 Average size and distribution of holding

Average size and distribution of operation holding of the selected farms over the three blocks of Dinhata subdivision and in the subdivision as a whole are presented in Table 2.13. From this table it is manifested that distribution of operational holding is more or less egalitarian over the three blocks except Dinhata-I and in the subdivision as a whole.

Average size of holding corresponding to each size group is almost the same over blocks. On an average in the subdivision as a whole the average size of holding is 1.66 hectare, which ranges from 0.69 hectare in the marginal size group to 3.73 hectare in the large size group.

Table: 2.13 Distribution of holding, cultivated area and average size of selected farms in various size groups in the selected blocks of Dinhata subdivision and in the subdivision as a whole

Name of the Block	Size of holding in Hactare	Farm group	No. Of selected holding	Cultivated area of the selected farms in Hactare	Average size of the selected farms in Hactare
Dinhata-I	<1	Marginal	43 (53.75)	21.18 (20.64)	0.49
	1-2	Small	24 (30.0)	33.99 (33.14)	1.42
	>2	Large	13 (16.25)	47.41 (46.22)	3.65
	Total	All farm	80 (100)	102.58 (100)	1.28
Dinhata-II	<1	Marginal	34 (42.5)	29.04 (20.10)	0.85
	1-2	Small	27 (33.75)	47.42 (32.83)	1.76
	>2	Large	19 (23.75)	68.20 (47.21)	3.59
	Total	All farm	80 (100)	144.45 (100)	1.80
Sitai	<1	Marginal	31 (38.75)	24.71 (16.40)	0.80
	1-2	Small	28 (35.0)	43.85 (29.11)	1.57
	>2	Large	21 (26.25)	82.09 (54.49)	3.91
	Total	All farm	80 (100)	150.66 (100)	1.88
Subdivision	<1	Marginal	108 (45.0)	74.93 (18.83)	0.69
	1-2	Small	79 (32.92)	125.26 (31.48)	1.61
	>2	Large	53 (22.08)	197.71 (49.69)	3.73
	Total	All farm	240 (100)	397.90 (100)	1.60

Note: Figure in the parenthesis indicate percentage of size of holding.

Source: Field Survey, 2012

2.2.1.2 Major Crops of the study area

Paddy, Tobacco, Jute, Oilseeds, potato, jute are the important crops grown in the study area. Aman and Jute are major kharif crops in all the blocks and Dinhata subdivision as a whole. Boro paddy, maize, potato, wheat, mustard and tobacco are majors rabi crops (Figure 2.20).

Table: 2.14: Area, Production and productivity of Principal crops in the study area

Crops		Dinhata-I	Dinhata-II	Sitai	Total
Aus	Area	1075	-	1546	2621
	Prod^n	1.889	-	2.001	3.89
	Yield	1757	-	1295	1526
Aman	Area	20101	18463	10581	49145
	Prod^n	40.168	32.845	19.985	92.998
	Yield	1998	1779	1889	1888.67
Boro	Area	9809	6615	2636	19060
	Prod^n	32.318	17.616	7.75	57.684
	Yield	3295	2663	2940	8898
Wheat	Area	111	632	62	805
	Prod^n	0.25	1.273	0.133	1.656
	Yield	2248	2015	2146	2136.33
Maize#	Area	1600	400	225	2225
	Prod^n	6.400	1.592	0.905	8.897
	Yield	4000	3980	4020	4000
Jute	Area	8170	10094	2835	21099
	Prod^n*	92.893	131.929	28.775	253.597
	Yield**	11.37	13.07	10.15	11.53
Masur	Area	7	53	-	60
	Prod^n	0.004	0.015	-	0.019
	Yield	539	289	-	414
Maskalai	Area	74	20	6	100
	Prod^n	0.027	0.01	0.004	0.041
	Yield	361	482	646	496.333
Khesari	Area	2	115	-	117
	Prod^n	0.002	0.113	-	0.115
	Yield	984	984	-	984
Mustard	Area	1013	1346	290	2649
	Prod^n	0.567	0.493	0.15	1.21

	Yield	560	366	517	481
Til	**Area**	5	6	7	18
	Prod^n	0.003	0.003	0.004	0.01
	Yield	551	551	551	551
Potato	**Area**	2265	2109	626	5000
	Prod^n	60.977	60.799	9.732	131.508
	Yield	26921	28828	15547	23765.3
Tobacco#	**Area**	1800	800	4600	7200
	Prod^n	2.34	1.032	6.026	9.398
	Yield	1300	1290	1310	1300

Area in hectare, **Production** in '000 MT and **Yield Rate** in Kg per hectare

* in 1000 bales of 180 kgs each ** in bales per hectare

Source: National Information system, Cooch Behar

 # Source: SAO, Dinhata

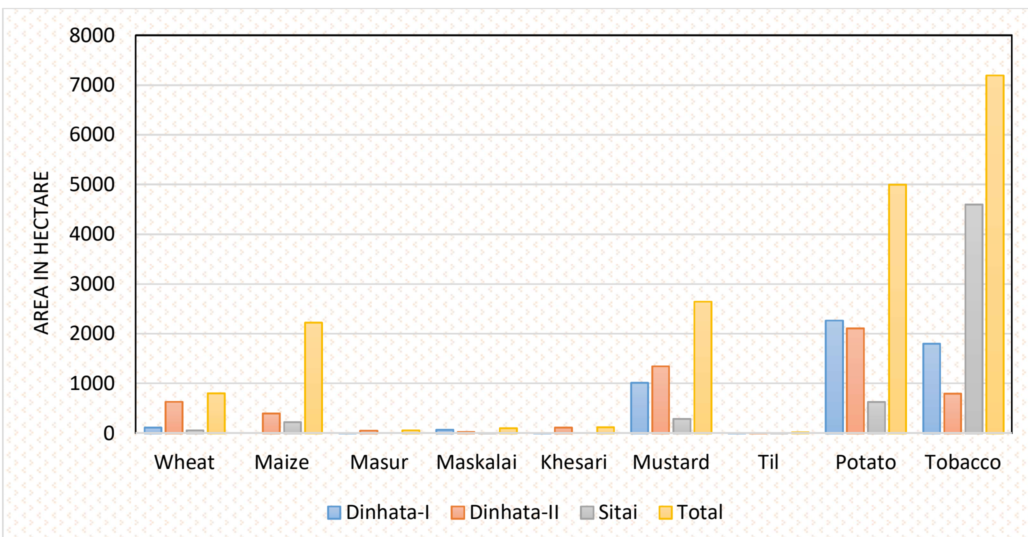


Figure: 2.20 Major rabi crops of the study area

2.2.1.3 Cropping Pattern

Season wise acreage allocation in absolute and percentage farm or in other words cropping pattern is dependent upon a number of factors like climate, soil suitability, water availability and access to market etc. The cropping pattern followed by the selected cultivators under different blocks and in the subdivision as a whole is displayed in table 2.15 Form this table it is noticed that there remains no size-wise variation in a particular season in a particular block. But there remains block-wise variation in the same in all the seasons except Khariff season.

Table: 2.15: Season-wise allocation of area in hectare under different crops and their percentage distribution in the study area

Season	Name of the Crop	Dinhata-I	Dinhata-II	Sitai	Total
Pre- Khariff Season	Aus Paddy	0.34	0.34	0.34	1.01
	Jute	15.71	15.71	15.71	47.14
	Vegetables	10.66	7.10	2.70	20.46
	Other cereal	-	-	0.27	0.27
	Maize	2.76	2.76	2.76	8.29
	Total	29.47	25.91	21.78	77.17
Khariff Season	Aman Paddy	67.40	70.55	87.77	225.71
	Vegetables	18.66	15.20	10.62	44.48
	Others	5.09	2.05	13.81	20.90
	Total	91.10	87.80	112.19	291.09
Rabi Season	Tobacco	33.45	18.75	52.41	104.61
	Maize	7.49	20.06	26.40	53.95
	Potato	10.70	14.67	8.60	33.97
	Pulses	2.60	6.69	1.96	11.25
	Oilseed	7.38	9.86	1.08	18.32
	Tomato	0.82	0.54	5.06	6.42
	Chilli	1.26	0.27	2.12	3.66
	Vegetables	14.67	11.56	7.11	33.33
	Wheat	2.43	7.10	5.53	15.05
	Others	0.83	1.88	5.04	7.75
	Total	81.63	91.37	115.30	288.30

Source: Field Survey 2012

2.2.1.4 Cropping Intensity

Land being a very scarce resource, multiple cropping is the alternative to increasing the effective area under crop production. The extent of multiple cropping as reflected in the intensity of cropping is determined by simple equation.

$$CI = \frac{GCA}{NCA} \times 100$$

Where,

CI= Cropping Intensity

GCA= Gross cropped area

NCA=Net cropped area

It is set out in table 2.16 for the selected farms under different size groups over different blocks and in the subdivision as a whole. This table manifests that there remains inter-block variation in the cropping intensity. It is also further evident from this table that cropping intensity is decreasing with the increase of the size of holding in all the selected blocks and in the subdivision as a whole.

Table: 2.16 Size wise Cropping Intensity in the Study area

Name of the Block	**Size of holding in hectare**	**Farm group**	**Net Cropped area in Hectare**	**Grossed cropped area in hectare**	**Cropping Intensity**
Dinhata-I	<1	Marginal	20.57	48.13	234.00
	1-2	Small	33.37	65.74	197.02
	>2	Large	45.79	83.34	181.98
	Total	All farm	99.73	197.21	197.74
Dinhata-II	<1	Marginal	24.36	48.51	199.12
	1-2	Small	41.62	72.17	173.39
	>2	Large	57.73	65.68	113.77
	Total	All farm	119.92	186.35	155.40
Sitai	<1	Marginal	22.86	48.91	213.93
	1-2	Small	34.68	65.83	189.84
	>2	Large	68.99	86.65	125.60
	Total	All farm	126.53	201.40	159.17
Subdivision	<1	Marginal	66.99	145.55	214.70
	1-2	Small	109.67	203.74	185.78

	>2	Large	172.51	235.67	136.61
	Total	All farm	346.18	584.96	168.98

Source: Field Survey, 2012

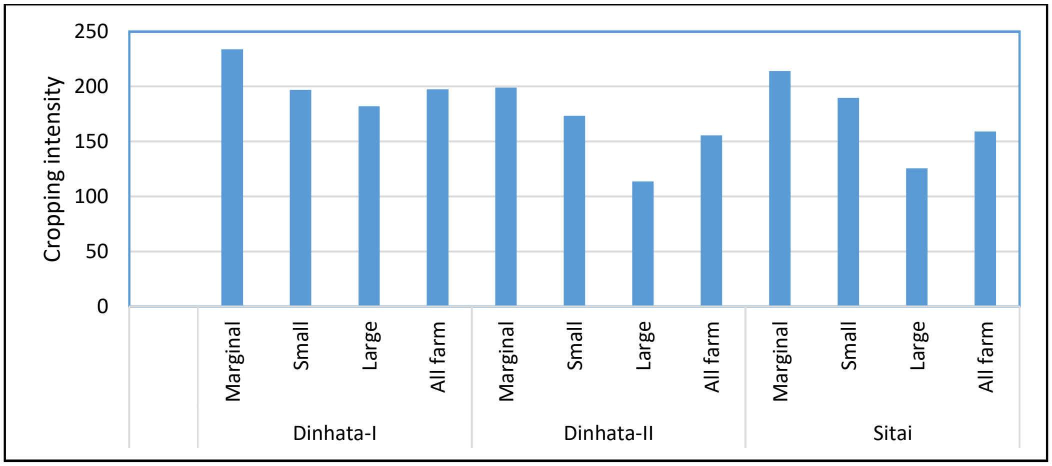


Figure: 2.21 Cropping intensity of the sample farm of the study area

2.2.1.5 Irrigation Status

Irrigation is one of the most important inputs in boosting agricultural production as it is greatly linked with efficiency of fertilizer application. Crop grown during Rabi season normally raised with full irrigation although some of these crops are raised on residual moisture as well as limited irrigation in some parts of the subdivision. Dinhata is an irrigation deficient subdivision. There are no major irrigation schemes worth mentioning in the subdivision. At present about 54.33% of the cultivable area is under irrigation (Village wise irrigation availability given in Appendix-B). The benefit of the Teesta irrigation cannels for the study area is perhaps distant possibility due to the topographical reasons. The study area is however blessed with large nos. of perennial rivers, khals, beels and water bodies. These resources are being utilized as a source of surface irrigation through a number of RLI and Mini RLI schemes. However, most of these RLI often remain unutilized or underutilization due to yearly flooding, meandering and heavy siltation of these rivers. But the ground water potential of the study area is very high. No doubt pump operated shallow tube well is the most viable and popular irrigation scheme among the farmers of the study area.

The extent of irrigation facilities over different sources in three blocks of Dinhata subdivision is manifested in table 2.17. Form this table it is observed that the irrigation facilities in terms of percentage of irrigation area to the total area under operation is very poor and varied over different blocks. According to national information system (NIC), Cooch Behar, a total of 28677 hectares of land is under irrigation, which accounted 54.33 percent of total agricultural land of the subdivision. The percentages of area under irrigation is the highest in Dinhata block-II (57.86 percent) and lowest in Sitai (45.94 percent). According to village directory private canals irrigate 240 hectare which covers 0.45 percent of total agricultural land, tank irrigate 850 hectare accounting only 1.61% of total agricultural land, whereas RLI irrigate 4286 hectare, which constitute 8.12 % of total agricultural land and DTW irrigate 1531 hectare accounting 2.9% of total agricultural land of the study area. On the other hand STW irrigate 19057 hectare of land which accounted 36.1% of total agricultural land and ODW irrigate only 248 hectare, which constitute 0.47% of total agricultural land of the study area.

Table: 2.17 Sources of Irrigation and area irrigated by different sources in the yare 2011-12

Sources of Irrigation		Dinhata-I	Dinhata-II	Sitai	Total
Private Canal	No	-	-	-	-
	Area in Ha	150	40	50	240
Tank	No	48	2	30	80
	Area in Ha	690	40	120	850
RLI	No	50	38	16	104
	Area in Ha	1820	1810	656	4286
DTW	No	24	15	4	43
	Area in Ha	890	486	155	1531
STW	No	5177	4342	1524	11043
	Area in Ha	8012	7545	3500	19057
ODW	No	21	19	20	60
	Area in Ha	85	68	95	248
Others	No	101	33	12	146
	Area in Ha	1020	1165	280	2465
Total	No	5421	4449	1606	11476
	Area in Ha	12667	11154	4856	28677

Agricultural land in Ha*	22939.33	19276.95	10569.5	52785.8
% of irrigated area	55.22	57.86	45.94	54.33

RLI= River lift irrigation, DTW= Deep tube well, STW=Shallow tube well, ODW=Open Dug well

Source: Cooch Behar NIC ** Source: Village Directory, Cooch Behar*

Conclusion

The study area is essentially flat, there are no hilly tract. The main river of the study area is Singimari. Geological succession of the subdivision is mainly sand, silt and clay. There is no forest worth mention. The agro-climatic condition of this subdivision is characterized as humid and damp throughout the year with long term average annual rainfall 2909.88 mm (1972-2011). Average monthly temperature was highest during August (28.28^{0}C) and lowest in January (15.43^{0}C).The average monthly humidity in the study area is 76.66 percent. Ground water of this subdivision is good and potable for both agricultural and domestic purpose. Total population of the study area was 676792 persons (2011 census) and density of population was 978 persons/sq km and about 72.72 percent of population was literate. Marginal farmers of the selected farms of the study area account for 18.83 percent of all holding. On the other hand, small farmers of the selected farms of Dinhata subdivision account for 31.48 percent of all land holding. About 22 percent large farmers constitute only 49.69 percent of the total land holding of selected farms. Irrigation status of the subdivision is not satisfactory. Paddy, Tobacco, Jute, Oilseeds, Vegetables are the important crops grown in the study area. Fifty percent of the total tobacco cultivation of the West Bengal is produced in Dinhata subdivision which regulates the daily economy of a large portion of farming and business community. The average cropping intensity of the selected farms of the subdivision was 168.98 and cropping intensity of marginal, small and large farms constitute 214.70, 185.75 and 136.61 respectively. The district has no reported economic mineral occurrences. The sand of the river beds; Flood plains and channel bars, being highly, micaceous is not suitable as construction material.

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