# CHAPTER – 3

# FACTORS FOR CHANGING AGRICULTURAL LAND USE

## 3.0 Introduction

The connections among different patterns of agriculture and their functioning and cultural attributes are being continually discussed by the planners. Although they are too intricate to allow for rigorous analysis, these do need thoughtful consideration in each plan (James and Lee, 1971). Like physical factors, cultural factors are also responsible for changing agricultural land use. The perspective of the population in the environmental investigation cannot be concluded at all without knowing the socio-economic conditions of a particular area because the population comprises of the society and improves the culture. Population studies are concerned not only with population variables but also with the relationships between population changes and other variables likes; social, economic, political, biological, genetic, geographical and the like (Philip, 1959). In this chapter, a generalized attempt is taken into consideration to confine the authenticity of the district and the different blocks in terms of the distribution of population, the density of population (1961-2011), growth of population, expansion of the urban area, expansion of irrigation and soil fertility.

### 3.0.1 Factors of agricultural land use

Land use is conditioned by the suggestion of two groups of aspects (figure 3.1), like;

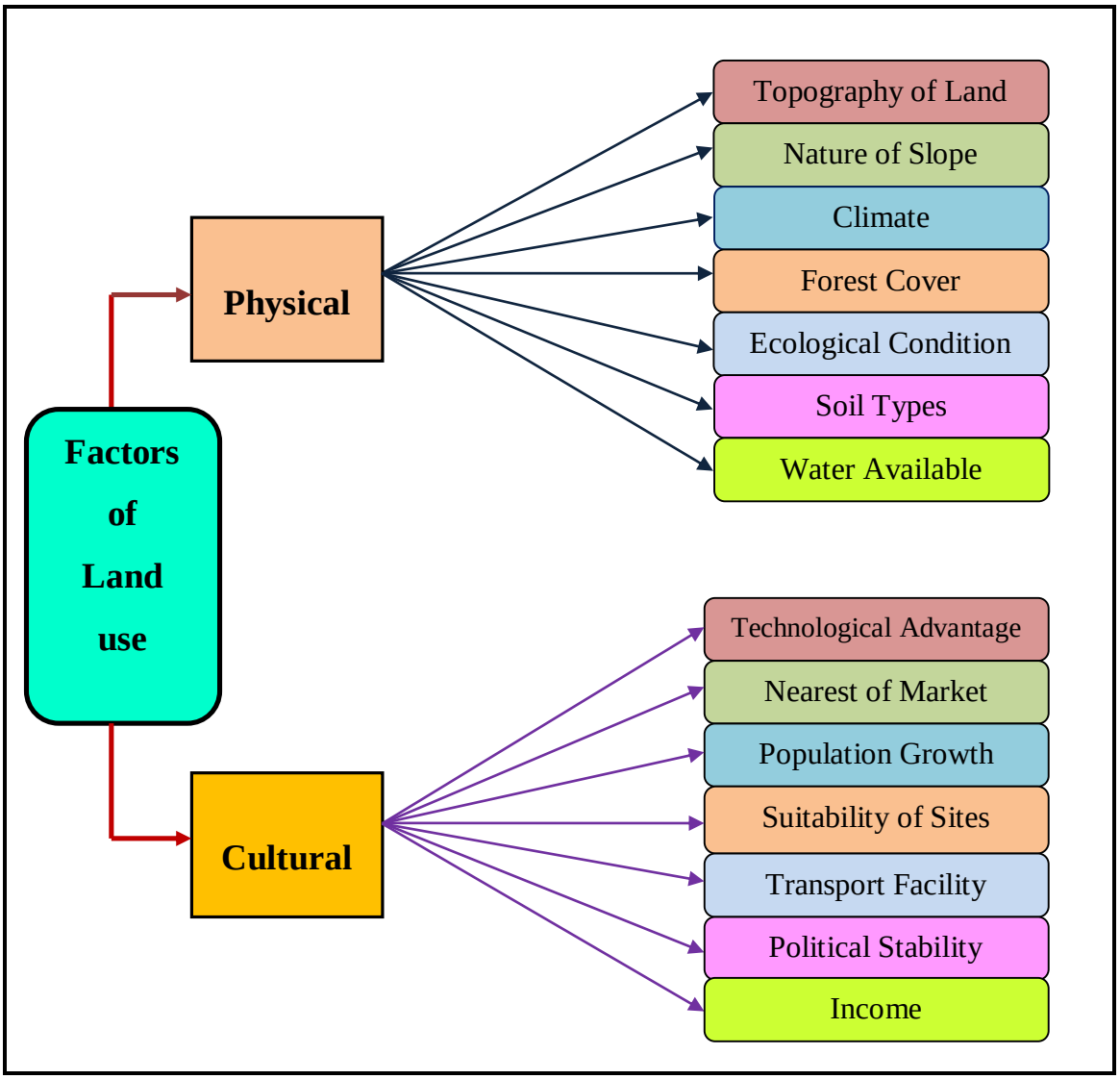
***Firstly:*** Physical factors such as relief features, soil condition and vegetation which limit the use capabilities of agricultural land.

***Secondly:*** Cultural features which contain both economic and institutional factors. Cultural factors represent the measurement of occupance of the area. Not only that, demographic and socio-economic conditions, institutional framework and the technological stages of the people which decide the extent to which the land can be applied (Nath, 1953).

Thus, in general, there are many factors responsible for the changes; important among them may be noted as follows:

i. The proximate aspect is related to direct human activity which affects land use but to a restricted field (agricultural land expansion, the extension of buildup areas etc.). This factor originates native level at separate or community level.
ii. The study area is flood-prone area, which occurs almost every year. Economic situations suffered very much by the inundation (1998 & 2017) during the flood time. People lost

their permanent agrarian fields. Inhabitants were compelled to go outside of the village to alternative earn but there was a claim to return in their agricultural land. Consequently, local people's demand acted as a major driving force to land use change in the study area (researcher's observation at the time of household survey).




Source: Mandal, 1990

**Figure 3.1** Physical and cultural factors of land use change.

iii. Cultural factors also play a vital role in agricultural land use changes. The villagers of the study area used to be involved in farming activities. Uttar Dinajpur District was capable of *aman*, *rabi* and *boro* paddy. Afterward the flood, fertility rate of soils increases and crop production is generally enhanced. But due to the destruction to crops, the farmers of the district had to go for non-agricultural activities (researcher's field observation).

iv. The increasing population and growing settlements essential more space for residence and production of crops. These have compelled the people to spread their settlements horizontally, however the whole area of land cannot be extended.

### 3.1 Distribution of population

The term population distribution refers to the way the people are spaced on the earth's surface. The distribution of population is more localized. The population size of individual districts provides a better understanding of population trends and patterns because a district is the political or small geographical unit in which decisions relating to population, environment and resources are made (Khullar, 2008). There are wide regional contrasts in the degree of concentration of population giving highly variable distribution to the different parts of the district. The uneven distribution of the population in Uttar Dinajpur is its most dominant feature. It is clear from the table 3.1 the population of the district was 7,74,487 in 1961 which has increased to 11,07,146 persons in 1971, 14,40,075 persons in 1981, 19,26,719 persons in 1991, 23,56,354 persons in 2001 and it reached 30,07,134 persons in 2011 Census (Census of India, 1961-2011).

**Table 3.1** Block-wise distribution of population in Uttar Dinajpur District (1961-2011).

| Name of the C.D. Blocks | 1961 | 1971 | 1981 | 1991 | 2001 | 2011 | Index of Growth (%) (1961-2011) |
|---|---|---|---|---|---|---|---|
| Chopra | 68,868 | 1,01,570 | 1,28,699 | 1,65,720 | 2,23,022 | 2,84,403 | 313 |
| Islampur | 87,942 | 1,33,945 | 1,71,780 | 2,30,326 | 2,41,951 | 3,62,858 | 313 |
| Goalpokher-I | 1,47,025 | 1,16,653 | 1,70,736 | 2,12,643 | 2,45,430 | 3,26,120 | 122 |
| Goalpokher-II | - | 97,210 | 1,14,530 | 1,49,824 | 2,26472 | 2,91,252 | 200 |
| Karandighi | 75,191 | 1,22,232 | 1,69,171 | 2,30,121 | 3,18,881 | 4,05,262 | 439 |
| Raiganj | 1,50,072 | 2,08,274 | 2,71,532 | 4,28,203 | 5,42,216 | 6,13,833 | 310 |
| Hemtabad | 46,769 | 62,000 | 77,881 | 95,157 | 1,18,822 | 1,42,056 | 204 |
| Kaliaganj | 93,911 | 1,22,407 | 1,53,769 | 1,87,935 | 1,90,019 | 2,77,672 | 196 |
| Itahar | 1,04,709 | 1,42,855 | 1,81,977 | 2,26,800 | 2,49,541 | 3,03,678 | 191 |
| **Uttar Dinajpur** | **7,74,487** | **11,07,146** | **14,40,075** | **19,26,729** | **23,56,354** | **30,07,134** | **289** |

Source: Computed from the Census of India (1961-2011).

A block-wise increasing trend of decadal population is being noticed (table 3.1). Three demographic factors i.e. increasing fertility, declining mortality and increasing immigration are responsible for the rapid growth of population in the district (Bhende and Kanitkar, 2003). From Census year 1961 to 2011 the total population has increased from 7,74,487 persons to 30,07,134 persons in the district. The net increased population in the district is 289 per cent (table 3.1) over the last five decades (1961-2011).

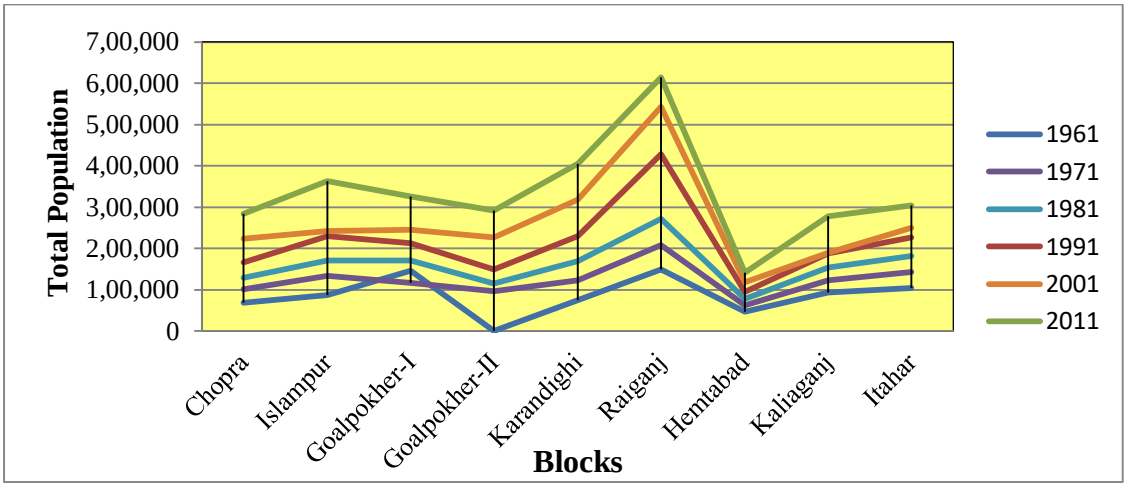



**Figure 3.2** Trend line showing decade wise populations distribution of Uttar Dinajpur District (1961-2011).

A large number of population has been migrated from different districts of different states as well as from neighbouring countries (Official records are not available but the researcher has observed during the time of households survey) after the independence. On the other side, rapid population growth was related to the social and economic developments resulting first from the application of agricultural revolution and then from the industrial developments and finally from advances in the medical science which may also be attributed to economic development in the district. The declining death rates and the unchanged high birth rates resulted in an increase in population growth in the district. Table 3.1 illustrates vividly how the population of the district has rapidly increased since 1961 and how the time taken to reach the population size has dramatically been increased over the years.

### 3.1.1 The actual growth of the population in Uttar Dinajpur District (1961-2011)

The growth of the high population for the study period is 439 per cent (table 3.1) between 1961 and 2011 recorded in Karandighi Block. But very low growth rate has been found in Goalpokher-I Block (122 per cent). For a better understanding of growth of population in the district, data in between 1961 to 2011 has been considered and represented in table 3.2.

**Table 3.2** Growth of population in Uttar Dinajpur District (1961-2011).

| Category of Growth | Growth Index (%) | No. of C.D. Blocks | Name of the C.D. Blocks |
|---|---|---|---|
| Very Low | <200 | 3 | Goalpokher-I, Kaliaganj and Itahar |
| Low | 200-300 | 2 | Goalpokher-II and Hemtabad |
| Medium | 300-400 | 3 | Chopra, Islampur and Raiganj |
| High | >400 | 1 | Karandighi |

Source: Compiled by researcher from table 3.1

A very low growth rate of population over the study is observed in three blocks namely, Goalpokher-I (122 per cent), Kaliaganj Block (196 per cent) and Itahar Block (191 per cent) (table 3.2). A very low rate of growth of population is due to low birth rates, and due to the implementation of family planning. Not only that, before the year 1981, the population growth rate was low in the district due to mostly the death of diseases and emigration of youth for the higher studies and seeking jobs elsewhere in the country or state. The medium population growth rate is observed in three blocks namely, Chopra (313 per cent), Islampur (313 per cent) and Raiganj (310 per cent). On the other hand, a high population growth rate is observed in Karandighi Block (439 per cent) in the district (figure 3.3). The growth rate is high in this block due to high birth rates, low implementation of family planning, improved medical facilities and immigration of peoples from other blocks because many small and medium industries (mainly rice mill industry) are located in this block.

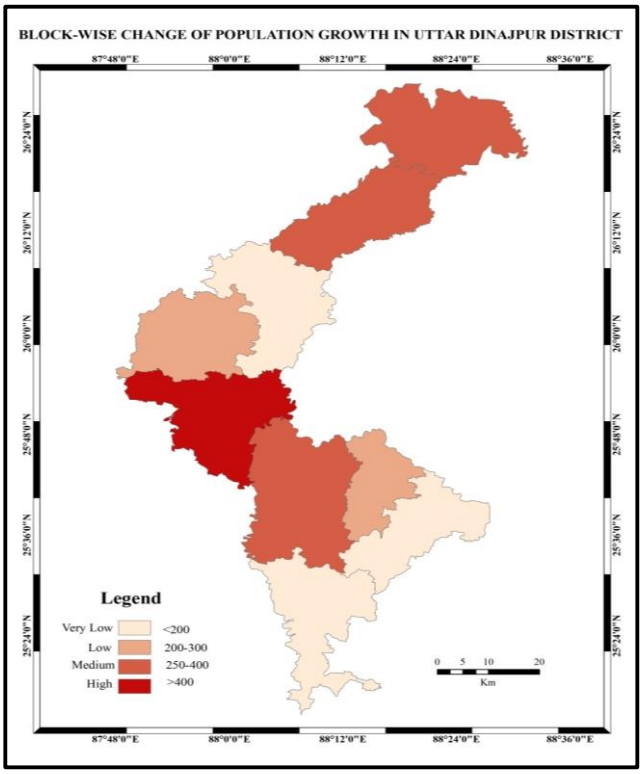



**Figure 3.3** Growth of population in Uttar Dinajpur District.

### 3.2 Density of population (1961-2011)

Population density is an important measure to the analysis of population distribution in the district and its influence on changes in agricultural land use patterns. The contemporary pattern of density of population is largely a reflection of land use in different blocks of the district and

to some context expression of carrying capacity of various regions. It is a simple man-land ratio and is defined as a number of persons living in a unit area of land. The density of the population in Uttar Dinajpur District was 247 persons per $km^2$ in the census year 1961. And it has increased from 707 persons per $km^2$ in 1991 to 958 persons per $km^2$ in 2011. Population density expressed in the following form-

**Population Density = Total population/ Total area**

The density of population in Uttar Dinajpur District in 2011

30,07,134 persons/3,140 $km^2$

= 958 persons per $km^2$

The density of population is certainly a more reflective measure than the size growth as it considers growth per unit area. In terms of size growth blocks with larger area coverage normally respond in a different tune than that of the blocks with lower area coverage. In this regard, the block-wise population density in Uttar Dinajpur District is shown for the year 1961-2011 in table 3.3 and figure 3.4.

**Table 3.3** Block-wise population density in Uttar Dinajpur District (1961-2011).

| **Name of the C.D. Blocks** | **Area ($km^2$)** | **1961** | **1991** | **2011** | **Change of density/$km^2$ (1961-2011)** |
|---|---|---|---|---|---|
| Chopra | 380.82 | 181 | 436 | 747 | 566 |
| Islampur | 331.20 | 266 | 696 | 1,096 | 830 |
| Goalpokher-I | 372.11 | 396 | 572 | 877 | 481 |
| Goalpokher-II | 298.69 | - | 502 | 976 | 474 |
| Karandighi | 390.52 | 193 | 509 | 944 | 751 |
| Raiganj | 472.13 | 318 | 907 | 1,301 | 983 |
| Hemtabad | 191.82 | 244 | 497 | 741 | 497 |
| Kaliaganj | 301.90 | 312 | 623 | 743 | 431 |
| Itahar | 362.40 | 289 | 626 | 838 | 549 |
| **Uttar Dinajpur** | **3,140.00** | **247** | **707** | **958** | **711** |

Source: Calculated from Census of India.

It is manifest from table 3.3 that, there are considerable spatial variations in the density distribution within the district. In the year 1961, the highest population density is observed in Goalpokher-I Block with 396 persons per $km^2$ and the lowest population density is observed in Chopra Block with 181 persons per $km^2$. On the other hand, according to 1991 census report that the highest population density has been noticed in Raiganj Block (907 persons per $km^2$) and the lowest population density has been observed in Chopra Block with 436 persons per $km^2$ and according to census 2011, Raiganj Block has the highest population density with 1,096 persons per $km^2$ and lowest population density has been found in Hemtabad Block with 741 persons per $km^2$. In between the year 1961 and 2011, the population density increased from 318 to1,301 persons per $km^2$ in Raiganj Block, from 181 to 747 persons per $km^2$ in Chopra

Block and 193 to 944 persons per km$^2$ in Karandighi Block. It is also has observed that population density increased in all the blocks of the district day-by-day due to increases in population, migration of peoples from the nearest block as well district and many others. Decadal change of density/ km$^2$ in Uttar Dinajpur District during the same period is represented in figure 3.5.

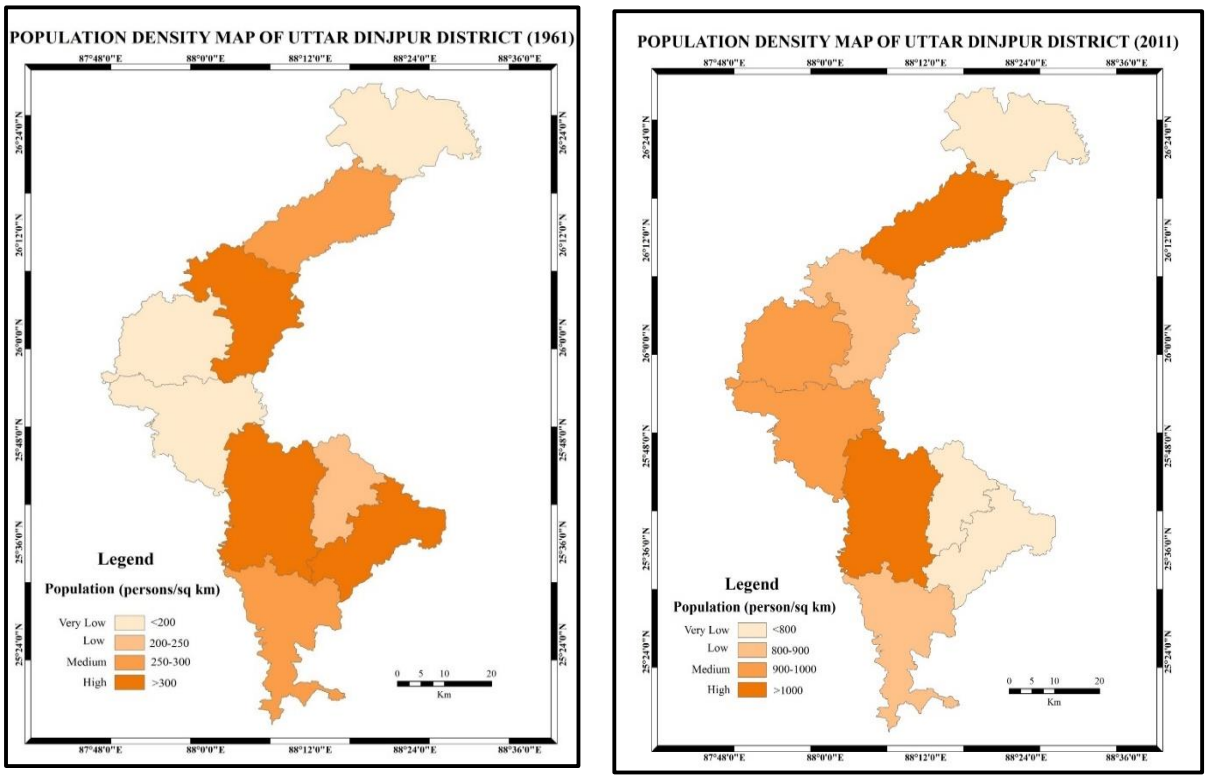



**Figure 3.4** Population density of Uttar Dinajpur District 1961 and 2011

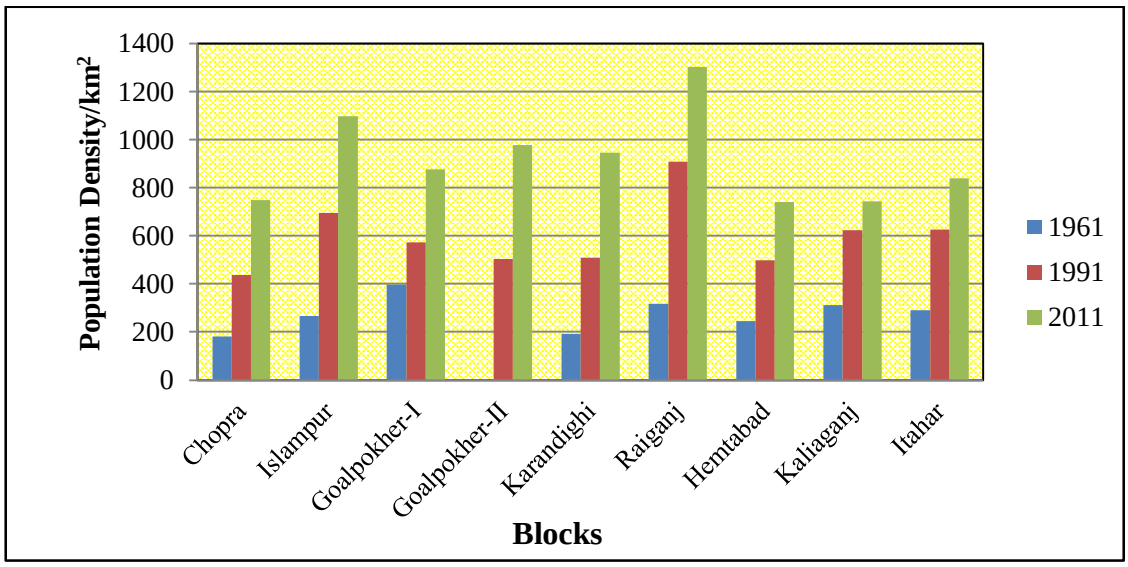



**Figure 3.5** Changes in population density (1961-2011).

### 3.3 Growth of population

Population growth is the change in the number of inhabitants of a territory during a specific period of time. Population change is often calculated for a period of ten years which is normally the time gap between two successive census operations. The spectacular acceleration on population growth was the product of a decline in mortality and the widening gap between the birth rates and death rates (Chandna, 2002). The causes of population growth are the gap between the births and deaths increased steadily for the next year. For a better understanding of population growth in the Uttar Dinajpur District as well as the decadal growth rate of population over the study period are considered and presented in the table 3.4.

**Table 3.4** Decadal growth rates of population in Uttar Dinajpur District (1961-2011)

| Census years | Total Population | Index size growth (%) | Decadal growth of population | |
|---|---|---|---|---|
| | | | Difference from previous decade | Percentage |
| 1961 | 7,74,487 | 100.00 | - | - |
| 1971 | 11,07,146 | 142.95 | 42.95 | 42.95 |
| 1981 | 14,40,075 | 185.93 | 42.98 | 30.07 |
| 1991 | 19,26,729 | 248.77 | 62.84 | 33.79 |
| 2001 | 23,56,354 | 304.24 | 22.29 | 22.29 |
| 2011 | 30,07,134 | 388.27 | 27.61 | 27.61 |
| (1961-2011) | 22,32,647 | 288.27 | 188.27 | 188.27 |

Source: Census of India (1961-2011) and compiled by the researcher.

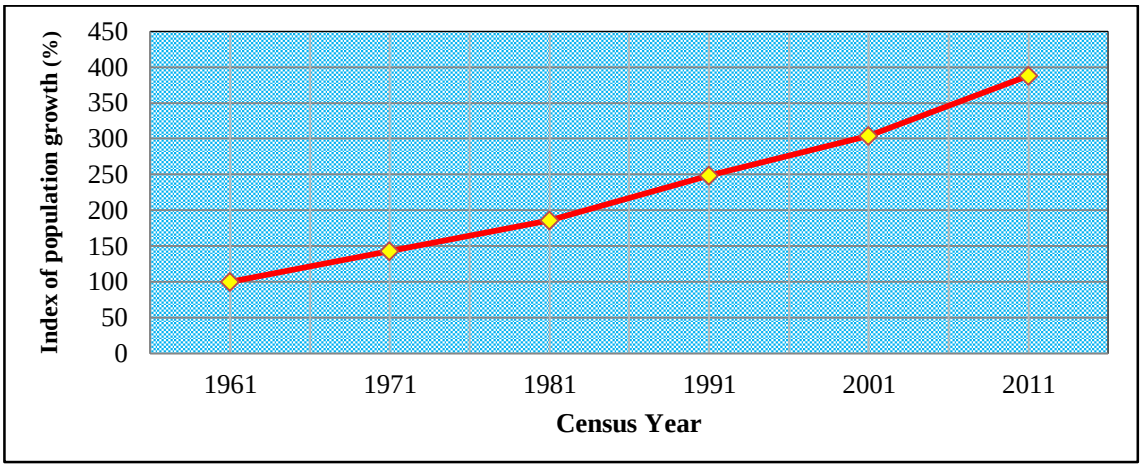



**Figure 3.6** Index size growth (%) in Uttar Dinajpur District.

Table 3.4 and figure 3.6 show that the course of the population decadal growth rate has increased during the period (i.e. 1961-2011). The average decennial growth rate was 42.95 per cent during 1961-2011, the growth rate has decreased from the previous decade i.e. from 42.95 per cent in 1971 to 30.07 per cent in 1981, decadal growth rate has again increased to 33.79 per cent during 1981-1991 but it has decreased to 22.29 per cent during 1991-2001 and during 2001-2011 it has again increased from 22.29 per cent to 27.61 per cent respectively. During

1961-2011, there has been an increase of 288.27 per cent of population all over the district. Uttar Dinajpur District's population has doubled during a period of 40 years (1961-1991) whereas India's population has been more than doubling in a period of 50 years (Census of India, 1961-2011).

The population of Uttar Dinajpur District has started increasing rapidly in the twentieth century and the annual growth rate has also been increased consistently. From table 3.4 it is clear that during the period 1961-1981, the average annual rate of district's population growth was 4.29 per cent but the period 1981-2011, it was decreased by 3.63 per cent. The lowest growth of total population in the district was observed during 1991-2001 (i.e. on an average, an annual growth rate is 1.01 per cent).

### 3.4 Decadal variation of population in Uttar Dinajpur District (1961-2011)

Decadal variation of population varies from one block to another block in the district. It is observed that in the year 1991-2001, the decadal variation of Uttar Dinajpur District has decreased. This is a very striking phenomenon. The decadal growth rate of the population during 1961-71 was 42.96 per cent, during 1971-81 it was 30.07 per cent, during 1981-91it was 33.79 per cent and during 1991-01 it was 22.29 per cent and 2001-2011 it has increased to 27.62 per cent. Thus, it is observed that the rate of population growth has decreased during 1971-81 and 1991-2001 in the district. For the proper concept of decadal change of population in the whole district are considered and represented in the table 3.5.

**Table 3.5** Block-wise decadal change of population growth in Uttar Dinajpur District.

| Years / Blocks | 1961-71 | 1971-81 | 1981-91 | 1991-01 | 2001-11 |
|---|---|---|---|---|---|
| Chopra | 47.48 | 26.70 | 28.76 | 34.57 | 27.52 |
| Islampur | 52.31 | 28.24 | 34.08 | 5.04 | 49.97 |
| Goalpokher-I | -20.65 | 46.36 | 24.54 | 15.41 | 32.87 |
| Goalpokher-II | - | 17.81 | 30.81 | 51.15 | 28.60 |
| Karandighi | 62.56 | 38.40 | 36.02 | 38.57 | 27.08 |
| Raiganj | 38.78 | 30.37 | 57.69 | 26.62 | 13.20 |
| Hemtabad | 32.56 | 25.61 | 22.18 | 24.86 | 19.55 |
| Kaliaganj | 30.34 | 25.62 | 22.21 | 1.10 | 46.12 |
| Itahar | 36.43 | 27.38 | 24.63 | 10.20 | 21.69 |
| **Uttar Dinajpur** | **42.96** | **30.07** | **33.79** | **22.29** | **27.62** |

Source: Census of India (1961-2011).

As a matter of fact, block-wise population distribution since 1961 is given and a total of these are considered as the total population of Uttar Dinajpur District. During 1961-71, the highest growth rate of 62.56 per cent was found in Karandighi Block of the district and its annual growth rate is 3.87 per cent. But the lowest population growth during 1961-71 was

found in Kaliaganj Block and it was increased to 30.34 per cent and the annual growth rate is 3.03 per cent. On the other hand, between 2001-2011 highest population growth rate was found in Islampur Block. But its rate of increase was 49.97 per cent and the annual growth rate was 4.99 per cent, the lowest population growth rate is found in Raiganj Block and it has increased to 13.20 per cent which indicates an annual growth rate of 1.32 per cent (table 3.5). The increasing population raises some questions concerning land uses in the district. Not only that, the population also increases gradually and shortens the interval between successive cropping periods. So, multiple and relentless cropping exhausts the fertility of the soil. These problems become more difficult and serious when farmers are using more land for commercial crops. In this way, when soil fertility arrives in low quality, agricultural land conversion to different land uses are common features in the district.

As each of these discussion points, it is important for an understanding of the growth of populations of Uttar Dinajpur District. Decadal population growth rate decreased during 1971-81, the underlying reason for such ups and down of growth rates is due to high mortality with various natural calamities like famines and epidemics as well as the war between India and Pakistan. On the other hand, during 1991-2001, population growth also decreased because of the partition of Uttar Dinajpur District from the erstwhile Dinajpur District. Another reason is that the weak monsoons and monsoon failure occurred in this decade. The situation regarding size of the population in 2011 in different blocks of Uttar Dinajpur District helps one to appreciate that great changes in size add distribution that has since taken place. These population changes show a fairly close relationship with increases in agricultural productivity. As such the distribution pattern of the population has altered considerably and its total number has greatly increased in areas that were brought under cultivation.

### 3.5 Change of land ownership

Land ownership is the fact of exclusive rights and control over the property which may be an object, land estate as well as intellectual property. Individual ownership replaces society ownership when agricultural land becomes rare and causes an increasing burden of farm households on arable land. Individual tenure in Uttar Dinajpur District is connected with the breakdown of the joint family system, sedentary cultivation and the overspill of people from densely populated to the sparsely populated potential agricultural lands. Since agriculture is the mainstay of farmers, it is natural that they should believe that one who owns the land owns wealth. The systems of land ownership vary depending on various factors, such as a basic distinction between the old alluvial settlements and rain fed farming areas on the one hand and

the reclamation and colonization of cultivable wasteland in new canal colonies on the other (Singh & Dhillon, 2005). In Uttar Dinajpur District, however, the peasant-proprietorship predominates. The systems of land ownership have built-in superior and inferior proprietorship. The majority of farmer's land is the inferior proprietors in the agricultural set up in the district. Not only that, it has also often been noted that farms owned by farmers near towns are small size and they increase in size with distance from the town, which a relatively high proportion of the farmers are leaseholders, and that part-time farming is common. It is true that, the expanding town may lead to the sale of part of the farm, and that land is expensive and therefore few farmers can increase their holding. The small size of farms may also provide an alternative explanation of the intensity of farming near the town; occupiers of small farms must choose enterprises with high net returns per unit area in order to make a living, and such farming is usually intensive-pigs, poultry, horticulture or dairying (Grigg, 1986). The very rapid extension of urban areas in the last forty-forty five years, combined with much greater mobility, means that an increasing part of farm areas is directly influenced by towns. Because of the differing reactions of farmers to this expansion, it is difficult to make generalizations about the structure and land use of the district. Land ownership is changing day to day in the district and its situations are clearly shown in table 3.6.

**Table 3.6** Change of total cultivators in Uttar Dinajpur District (1971-2011).

| Years / Blocks | Total Cultivators | | | Growth in (%) | | Index of Growth (%) |
|---|---|---|---|---|---|---|
| | **1971** | **1991** | **2011** | **1971-1991** | **1991-2011** | **1971-2011** |
| Chopra | 18,318 | 22,351 | 19,733 | 22.02 | -11.72 | 7.72 |
| Islampur | 24,175 | 27,618 | 27,957 | 14.24 | 1.22 | 15.64 |
| Goalpokher-I | 22,450 | 31,221 | 31,366 | 39.06 | 0.46 | 39.71 |
| Goalpokher-II | 15,048 | 23,025 | 20,158 | 53.01 | -12.45 | 33.96 |
| Karandighi | 17,401 | 31,008 | 30,532 | 78.20 | -1.53 | 75.46 |
| Raiganj | 25,018 | 40,661 | 40,441 | 62.53 | -0.54 | 61.64 |
| Hemtabad | 11,331 | 13,618 | 14,537 | 20.18 | 6.75 | 28.29 |
| Kaliaganj | 21,106 | 25,387 | 34,348 | 20.28 | 35.29 | 62.74 |
| Itahar | 24,982 | 40,525 | 35,419 | 62.22 | -12.60 | 41.78 |
| **Uttar Dinajpur** | **1,79,829** | **2,55,414** | **2,54,491** | **42.04** | **-0.36** | **28.64** |

Source: Computed by the researcher from the Census of India (1971, 1991 & 2011).

From the table 3.6, it is observed that in Uttar Dinajpur District 1,79,829 cultivators was in 1971, which increased to 2,55,414 in 1991 and in 2011, it decreased to 2,54,491 i.e. actual growth rate is 42.04 per cent in between 1971 and 1991, but it is decreased -0.36 per cent in between 1991and 2011 due to conversion of agricultural land to other uses, change of occupational pattern of the farmers. Many small farmers had to sale their land for uneconomic uses and they took the other occupations which are more profitable than agriculture. On the

other hand, the actual index of the growth rate of the cultivators increased 28.64 per cent between 1971 and 2011 in the district. The reasons for the growth of cultivators due to operational holdings during the last five decades clearly indicate a greater degree of fragmentation of lands resulting in a large number of uneconomic size of holdings, pressure of increasing population, high value and high demand of agricultural land in the study area. Above all, the fragmentation of the joint family to a single one in the district is responsible for a number of cultivators.

In Uttar Dinajpur District, the common size of holding is very small. In fact, about 79 per cent of the total holdings are below 1 hectare (As per the Statistical Hand Book Report, 2015). The average standard amount of holding that may present better agricultural returns cannot be maintained because of the fast increasing rural population and the prevailing law of inheritance. According to the law of inheritance in the district, the property is decreased uniformly divided among the male heirs. Each son normally insists on having a share from each location and from each portion of land, resulting in additional fragmentation of land as well as a change of ownership. It is a wasteful and uneconomic technique of land utilization in which enhanced agricultural practices cannot be adopted. The small fields are complicated to work with modern machinery, tractors and harvesters, etc. in the judgment of agricultural economists; the fragmentation of holdings is a great barrier and one of the major deterrents to economically feasible cultivation. So, cultivators are bound to change the crop as well as agricultural land use change. It is necessary to mention here that, the division of holdings may be socially justifiable but economically they are not viable and it is true that, as much land would fragmentation of holdings to that amount change the ownership of land.

### 3.6 Expansion of urban area (1961-2011)

The urban area is a modern phenomenon in human history. The process and characteristics of the urban area vary from one place to another. There are two types of towns identified by the census in the study area, like;

a) The municipality or statutory town and
b) Census or non-municipal town.

In the study area, there are four statutory towns and three census towns. Urban land use is defined as a spatial aspect of the type of human activities on a piece of land to serve human needs, such as residential, commercial or industrial. In the district, the growth of settlement is directly related to the growth of the population. Some of the urban areas are experiencing a

rapid pace of settlement growth. To understand the expansion rate of the urban area in Uttar Dinajpur District is given in the table 3.7.

**Table 3.7** Block-wise expansion of the urban area of Uttar Dinajpur District (1971-2011).
(Area in $km^2$)

| Name of the C.D. Blocks | Total area | Urban area 1971 | | Urban area 1991 | | Urban area 2011 | |
|---|---|---|---|---|---|---|---|
| | | Total | % | Total | % | Total | % |
| Islampur | 331.20 | 13.90 | 4.19 | 13.99 | 4.22 | 13.99 | 4.22 |
| Karandighi | 390.52 | 2.10 | 0.54 | 2.12 | 0.55 | 2.12 | 0.55 |
| Raiganj | 472.13 | 10.64 | 2.25 | 14.54 | 3.07 | 16.58 | 3.51 |
| Kaliaganj | 301.90 | 8.99 | 2.98 | 8.99 | 2.98 | 8.99 | 2.98 |
| **Uttar Dinajpur** | **3,140** | **35.63** | **1.13** | **39.64** | **1.26** | **41.68** | **1.32** |
| **Note:** Chopra, Goalpokher-I, Goalpokher-II, Hemtabad and Itahar Blocks are the totally rural Blocks. | | | | | | | |

Source: Census of India (1971-2011).

From the table 3.7 it is observed that the expansion of urban areas increased in Islampur Block from 13.90 $km^2$ to 13.99 $km^2$ from 1971 to 2011 and has recorded positive volume of change of 4.19 per cent to 4.22 per cent during the study period. It is revealed that a huge change in an urban area is found in Raiganj Block during the year 1971-2011. The urban area was 10.64 $km^2$ during the year 1971 and it has increased to 14.54 $km^2$ during the year 1991 and it has again increased to 16.58 $km^2$ in 2011, which consists of 2.25 per cent, 3.07 per cent and 3.51 per cent respectively. Net expansion in urban areas from the year 1971 to 2011 is 5.94 $km^2$. The decline of population percentage and increasing urban areas indicate agricultural land converted into settlement areas, industrial areas, etc. In this regard, the percentage shares of the urban population are necessary to consider as given in table 3.8.

**Table 3.8** Percentages share of the urban population in Uttar Dinajpur District (1971-2011).

| Name of the C.D. Blocks | Urban population 1971 | | Urban population 1991 | | Urban population 2011 | |
|---|---|---|---|---|---|---|
| | Total | % | Total | % | Total | % |
| Chopra | - | - | - | - | *5,777 | 1.66 |
| Islampur | 15,715 | 18.33 | 45,240 | 17.88 | 54,340 | 15.69 |
| Goalpokher-I | - | - | - | - | *5,939 | 1.71 |
| Karandighi | 5,622 | 6.56 | 10,652 | 4.21 | 36,930 | 10.66 |
| Raiganj | 43,191 | 50.39 | 1,59,266 | 62.95 | 1,83,612 | 53.04 |
| Kaliaganj | 21,169 | 24.70 | 37,817 | 14.94 | 53,530 | 15.46 |
| Itahar | - | - | - | - | *6,022 | 1.73 |
| **Uttar Dinajpur** | **85,697** | **100** | **2,52,975** | **100** | **3,46,150** | **100** |

Source: Census of India (1971, 1991 & 2011).
*Non-municipality population.

During the period 1971-2011, the total urban area has increased in every decade in the district. In Islampur Block, it is observed a decline of population but an increase of urban area i.e. it was 13.90 $km^2$ in 1971 but it has increased to 13.99 $km^2$ in 1991. But the population situation is opposite, the total urban population was 15,715 persons which consisted 18.33 per cent of the total block population and 17.88 per cent and 15.69 per cent of total block population

in 1991 and 2011 respectively (table 3.8). The total urban area of Karandighi Block was 2.10 $km^2$ in 1971 which reached 2.12 $km^2$ in 1991 and in 2011 the urban area.

The urban population was 6.56 per cent in 1971, but it has decreased to 4.21 per cent in 1991 and it has again increased to 10.66 per cent in 2011. On the contrary, the population was 5,622 persons in 1971, 10,652 persons in 1991 and in the year 2011, it has increased and reached 36,930 persons. On the other side, in Raiganj Block urban population was 43,191 persons in 1971, it increased to 1,59,266 persons in 1991 and in between 1991-2011 it increased to 1,83,612 persons. It consisted of 50.39 per cent in 1971, 62.95 per cent in 1991 and 53.04 per cent in 2011 of the total urban population respectively (table 3.8).

But in Kaliaganj Block, the total urban population was 21,169 persons in 1971, it increased to 37,817 persons in 1991 and during 1991-2011, it has increased to 53,530 persons. These constitute 24.70 per cent in 1971 and in between 1971 and 1991 it decreased from 24.70 per cent to 14.94 per cent. But in between 1991-2011 it has again increased from 14.70 per cent in 1991 to 15.46 per cent in 2011 of the total urban population (table 3.8 and figure 3.12). From the overall study, except Kaliaganj Block, all block's urban area has increased in the district. Not only that, according to the 2011 census there are three non-municipality areas which are found in Uttar Dinajpur District namely Chopra with 5,777 population, Goalpokher-I with 5,939 population and Itahar with 6,022 population. But urban areas have increased at a tremendous rate in Raiganj Block. Increasing population pressure and rapidly increasing of the urban area in Islampur, Karandighi and Raiganj Block is responsible for agricultural land conversion to non-agricultural uses in growing towns. For a better understanding, the level of actual agricultural land which was converted to other land in the district is shown in the table 3.9.

**Table 3.9** Actual loss of agricultural land in Uttar Dinajpur District (1971-2011).

| **Name of the Minucipality** | **Time in years** | **Area in $km^2$** | | | **% to the total block area in 2011** | **Growth of urban area expansion (in percentage)** | | |
|---|---|---|---|---|---|---|---|---|
| | | **1971** | **1991** | **2011** | | **1971** | **1991** | **2011** |
| Islampur | 40 years | 13.90 | 13.99 | 13.99 | 4.26 | 100 | +0.65 | +0.65 |
| Karandighi | | 2.10 | 2.12 | 2.12 | 0.56 | 100 | +0.95 | +0.95 |
| Raiganj | | 10.64 | 14.54 | 16.58 | 3.56 | 100 | +36.65 | +55.83 |
| Kaliaganj | | 8.99 | 8.99 | 8.99 | 2.98 | 100 | **No expansion of the urban area**. | |
| **District** | | **35.63** | **39.64** | **41.68** | **1.32** | **100** | **+11.25** | **+16.98** |

Source: Census of India 1971, 1991 and 2011

It is shown in table 3.9, in Islampur Block, there was 0.65 per cent of urban area expansion from 1971 to 2011, Karandighi Block's urban area has grown 0.95 per cent from 1971 to 2011, in Raiganj Block urban area has grown to 36.65 per cent in between 1971 to 1991 and 55.83

per cent in between 1991-2011 i.e. the highest urban area growth in the district. Overall the district situation of urban area expansion is 11.25 per cent in between 1971-1991 and it has increased to 16.98 per cent in between 1991-2011. Not only that, the total percentage shared of the urban area in the district 1.32 per cent. The urban area has grown by residential colonies, railway lines, shopping mall, parks, etc. The major causes of the decline in the agricultural area are primarily pressure on land for urban expansion. Non-agricultural uses of urban land have experienced the highest rate of increase due to changing structure of the economy. The contribution from road lines, industrial, settlement area and service sectors has increased considerably. In the district urban settlements are expanding at an accelerated rate and are encroaching upon the agricultural land. Thus, the area under non-agricultural uses is increasing at the expanse of agricultural land.

In recent times, the structure of many urban areas in Uttar Dinajpur District is changing drastically. This land use change is mostly caused by rapid urbanization which results from changes in an urban environment such as increased population, growth of institutions and swift growth of economic and industrial activities.

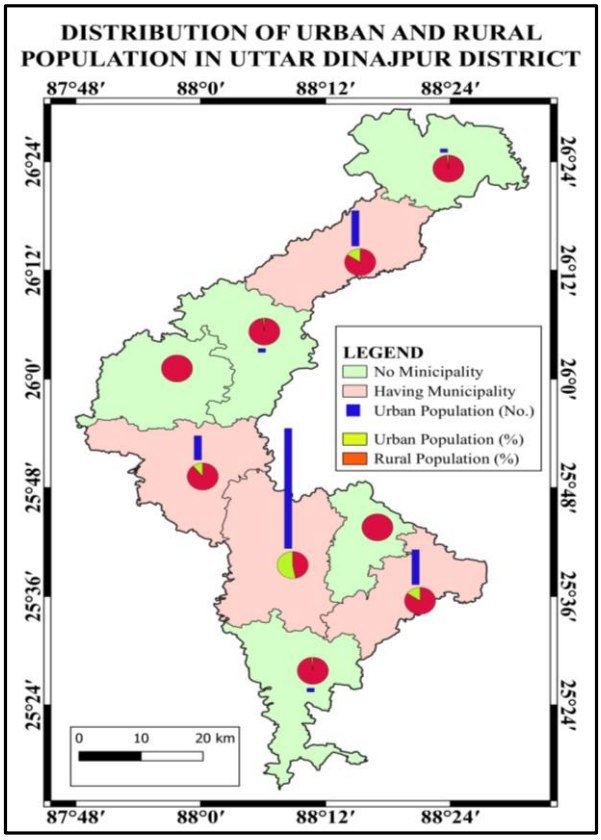



**Figure 3.7** Distribution of non-municipality and municipality block and urban & rural population in Uttar Dinajpur District.

There is a change in culture and way of living due to rapid urbanization. The rapid increase of urban areas indicates a possible impact of an adjacent area of urban centre on agricultural land and the district has led to the loss of fertile agricultural lands.

### 3.7 Expansion of irrigation area (1971-2011)

Irrigation is basically an agricultural operation and supplying the needs of a plant for water. Irrigation denotes the provider of water by man-made means to standardize the growth of the plant. Irrigation has a critical part in agriculture and rural improvement (Barker and Molle, 2004). The use of irrigation water in arid and semi-arid regions of the world can be traced back to the "draw of Neolithic agricultural revolution". However, its extensive use for agricultural development all over the world started in the 19$^{th}$ century. Only with adequate improvement in engineering techniques, making it possible to dam considerable rivers and to construct other structures, perennial channel irrigation to cover large alluvial basins become practicable. Similarly, advances in water pumping equipment made it potential to develop the water for irrigation on a large scale (Kumar, 2007). Uttar Dinajpur District requires an extension of the new irrigation scheme or the development of an active irrigation system and practices to make sure the most advantageous land utilization throughout water use. Other elements are economic and social development to an enormous extent depends upon the creation of excess agricultural production. Better water management can probably do more towards growing agricultural production both of food and non-food crops in the irrigated area of the world than the other agricultural practice (Jha, 1984). After the green revolution, the farmers have introduced new agricultural technology, the importance of irrigation as a key element in agricultural development has further increased in the district. Not only that, it is an important component of new inputs in agricultural sectors i.e. fertilizers, insecticides, and weedicides, pesticides and high yield varieties of seeds. It in turn promotes the trends of use of irrigation in a synergistic procedure of agricultural improvement. To understand the extent of an irrigation area in Uttar Dinajpur District related data is shown in table 3.10 (Appendix III).

From the table 3.10, it is revealed that the spatial distribution of irrigation was not uniform in all blocks of the study area. The area of irrigation in the district has increased significantly. It has increased from 7,466.68 hectares in the year 1971 to 47,727.15 hectares in the year 1991 and 1,51,591 hectares in the year 2011, which is about seven times increase in an irrigation area in between 1971-1991 and during 1991-2011 it has increased about four-fold in the district. The actual focus has been on the expansion of minor irrigation schemes in the form of shallow and deep tube wells i.e. supply to the farmer's immediately and all time irrigation. This

improvement in irrigation facilities has been made possible by the availability of rural electrification, different schemes taken from the Government and financial support from the local finance offices as well as local banks. According to the data structure of the table 3.10, it is to understand the irrigation expansion patterns discussed in the following categories:

A. Status of irrigation in 1971

B. Status of irrigation in 1991

C. Status of irrigation in 2011

**A. Status of irrigation in 1971**

Irrigation status has been quite significant in the study area. It varied between the lowest 0.17 per cent in Chopra Block and the highest 28.22 per cent in Hemtabad Block (table 3.10 and figure 3.13). The dissimilar distribution was governed by such factors like - situation of topography, depth of ground water table in different seasons, improvement of technology and nature of crops, etc. For a better understanding, the status was categorized into three and given in table 3.11.

**Table 3.11** Status of an irrigation area in Uttar Dinajpur District, 1971

| Irrigation Category | Irrigation area (%) | No. of C.D. Blocks | Name of the C.D. Blocks |
|---|---|---|---|
| Low | <5 | 7 | Chopra, Islampur, Goalpokher-I, Goalpokher-II, Karandighi, Raiganj and Itahar |
| Medium | 5-10 | 1 | Kaliaganj |
| High | >10 | 1 | Hemtabad |

Source: Computed by the researcher from table 3.10

From the table and data structure of table 3.11, the level of irrigation status and findings are discussed below:

**i. Low status of irrigation area**

The low status of irrigation area has been found in seven blocks namely Chopra, Islampur, Goalpokher-I, Goalpokher-II, Karandighi, Raiganj and Itahar with an irrigation status of 0.04 per cent, 0.06 per cent, 0.41 per cent, 1.29 per cent, 1.38 per cent, 3.90 per cent and 3.69 per cent respectively of the district total irrigated area. This zone lies in the north to middle part of the district (figure 3.8). The causes of the low status of irrigation are undulating surface, no canals are present, sufficient shallow tube wells but most of the tube wells, as well as deep tube wells, are useless and the depth of water level below average.

**ii. Medium status of irrigation area**

The medium category of irrigation status covered only one block namely, Kaliaganj with irrigated area 6.52 per cent. This zone lies in the southern part of the district (figure 3.8). The

main causes for the medium status of irrigation were also the availability of surface flow and storage system, private surface lift system, shallow tube wells (STWs). In this category availability of shallow tube wells and government tube wells are higher than the high status of the irrigated area. Notwithstanding, the irrigation area is medium status, its causes in these two blocks are soil is sandy types and presence of deep subsoil water level.

**iii. High status of irrigation area**

From the table 3.11, a high irrigation area was found in one block namely, Hemtabad with an irrigated area of 14.11 per cent of the total irrigated area in the district. This zone lies in the south-eastern part of the district (figure 3.8). The main causes of improvements in irrigation were the availability of surface flow and storage facility, lift system, shallow tube wells (STWs), deep tube wells (DTW) as well as govt. shallow tube well (TWs), surface-deep tube wells (STWs).

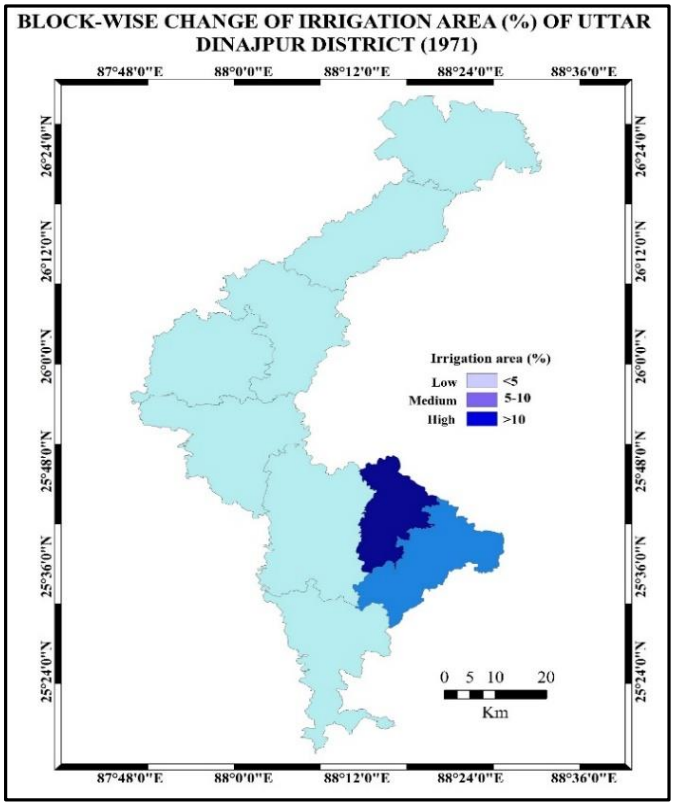



**Figure 3.8** Irrigation area of Uttar Dinajpur District 1971

**B. Status of irrigation in 1991**

In this year irrigation area has increased from 7,466.68 hectares in 1971 to 47,727.15 hectares in 1991. Hence, the status of irrigation varied between 0.07 per cent in Chopra Block to 37.60 per cent in Karandighi Block (table 3.11). The dissimilar distribution was also governed by such factors as- the undulating topography, a variation of ground water table in different

seasons, improvement of technology and nature of cultivated crops, etc. This is also categorized and represented into three categories and findings are given in the table 3.12.

**Table 3.12** Status of an irrigation area in Uttar Dinajpur District, 1991

| Irrigation Category | Irrigation area (%) | No. of C.D. Blocks | Name of the C.D. Blocks |
|---|---|---|---|
| Low | <10 | 3 | Chopra, Islampur and Goalpokher-I |
| Medium | 10-20 | 3 | Goalpokher-II, Hemtabad and Kaliaganj |
| High | >20 | 3 | Karandighi, Raiganj and Itahar |

Source: Computed by the researcher from the table 3.10

**i. Low status of irrigation area**

In this category, the status of irrigation ranges from 0.04 to 7.21 per cent. It has been found that in three Blocks namely Chopra, Islampur and Goalpokher-I have irrigation status 0.04 per cent, 0.08 per cent and 7.82 per cent respectively of the total irrigated area of the blocks. This zone lies in the northern parts of the district (figure 3.9). The causes of the low level of irrigation are undulating surface, lack of canals and shallow tube wells but most of the tube wells, as well as deep tube wells, are useless and depth of water level below average. Not only that, this zone is found in the north and north-eastern part of the district where the topography is high and area has mostly leveled having a slope from North to South. Irrigation is necessary since water cannot stay for more than a few days due to various topographical features.

**ii. Medium status of irrigation area**

The medium category of irrigation covered only three blocks namely Goalpokher-II, Hemtabad and Kaliaganj with an irrigation status of 18.10 per cent, 16.77 per cent and 14.10 per cent respectively. This zone lies in the northern and south-eastern part of the district (figure 3.9). The main causes for the medium status of irrigation are the availability of surface flow and storage system, private surface lift system, shallow tube wells (STWs), deep tube wells as well as govt. shallow tube wells (TWs), surface deep tube wells (STWs). In this category availability of shallow tube wells and govt. tube wells are higher than the high status irrigated areas. Notwithstanding these, the irrigation area is medium status because in these two Blocks soil is sandy types and deep subsoil water level is present.

**iii. High status of irrigation area**

From the table 3.12 high status of an irrigation area in the year 1991 was found in three blocks namely, Karandighi, Raiganj and Kaliaganj with the irrigation status 37.60 per cent, 29.69 per cent and 28.23 per cent respectively of the total irrigated area of the blocks. This zone lies in the central and southern parts of the district (figure 3.9). The main causes of the high status of

irrigation were the availability of surface flow and storage system, private surface lift system, shallow tube wells (STWs), deep tube wells as well as govt. shallow tube wells (TWs), and surface deep tube wells (STWs).

### C. Status of irrigation in 2011

In the year 2011, the overall status of irrigation in Uttar Dinajpur District is recorded between 70.08 per cent in Goalpokher-I Block to 88.23 per cent in Goalpokher-II Block (table 3.13). In this year irrigation status has been more or less uniform among all of the blocks. Such a similar distribution is governed by such factors as- development of minor irrigation projects, changing cropping patterns, increases of government shallow tube wells, improvement of irrigation technology, etc. This is categorized and represented into three categories and findings are given in the table 3.13.

**Table 3.13** Status of an irrigation area in Uttar Dinajpur District, 2011

| Irrigation Category | Irrigation area (%) | No. of C.D. Blocks | Name of the C.D. Blocks |
|---|---|---|---|
| Low | <72 | 3 | Chopra, Goalpokher-I and Raiganj |
| Medium | 72-78 | 3 | Islampur, Karandighi and Itahar |
| High | >78 | 3 | Goalpokher-II, Hemtabad and Kaliaganj |

Source: Computed by the researcher from the table 3.10

#### i. Low status of irrigation area

This category of irrigation status is observed in three blocks namely Chopra, Goalpokher-I and Raiganj with irrigation status 71.23 per cent, 70.08 per cent and 71.83 per cent respectively (table 3.10). This zone lies in the northern and south-eastern part of the district (figure 3.11). In the case of Chopra undulating and dissected topography, high cost of sinking tube wells, low density of tube wells irrigation and partly absence of canal irrigation is responsible for low status. And in Hemtabad Block presence of plane topography, water depth near the surface, development of technology and irrigation were available but the absence of canal irrigation and low density of shallow tube wells and government tube wells are responsible for low status.

#### ii. Medium status of irrigation area

Medium category of irrigation status is observed in three blocks namely, Islampur, Karandighi and Itahar with irrigation status 77.80 per cent, 76.05 per cent, and 77.32 per cent respectively of the total irrigated area of the district. This zone lies in the northern and southern parts of the district (figure 3.10). The main causes of the medium status of irrigation were the non-availability of surface flow and storage system, low private surface lift system, low density of shallow tube wells (STWs), deep tube wells as well as government shallow tube wells (TWs) and surface deep tube wells (STWs).

The situation of surface flow and storage system, shallow tube wells (STWs) and deep tube wells, as well as government shallow tube wells (TWs) in Islampur Block, are 80, 4,500 and 376 respectively. The situation of surface flow and storage system, shallow tube wells (STWs) and deep tube wells, as well as government shallow tube wells (TWs) in Goalpokher-I Block, are 90, 4,225 and 1,868, in Goalpokher-II Block are 110, 4,895 and 968, in Kaliaganj Block are 100, 5,417 and 1,308, in Itahar Block are 120, 7,962 and 1,476 respectively (table 3.14). In this category availability of shallow tube wells and government tube wells are higher than the high status of the irrigated area. Notwithstanding, irrigation area is medium status because in these five Blocks soil is sandy types and presence of deep subsoil water level.

**iii. High status of irrigation area**

In the study area, the high status of irrigation is limited to three blocks namely Goalpokher-II, Hemtabad and Kaliaganj with the irrigation status index 88.23 per cent, 86.23 per cent and 83.40 per cent respectively. This zone lies in the middle part of the district (figure 3.10). Causes of high status irrigation are plane surface, availability of adequate aquifers, water depth level near the surface (average depth of water level is 10 to 12 meters). So, the sinking cost of shallow tube wells is low and the availability of the electrification system in rural areas is high.

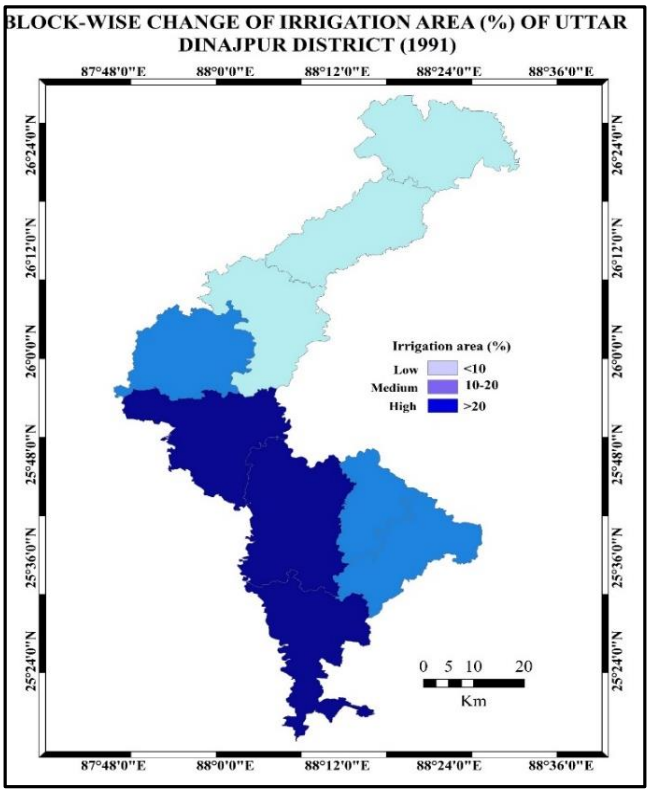



**Figure 3.9** Irrigation area of Uttar Dinajpur District, 1991

Not only that, the number of principal sources of irrigation in Karandighi Block like surface flow and storage system is 151 in number, shallow tube wells are 6,600 in number, Government

shallow tube wells are 1,268 in number and in Raiganj Block surface flow and storage system are 195 in number, shallow tube wells are 10,896 in number and Government shallow tube wells are 1,776 in number respectively in this period (table 3.14) i.e. the highest number in the district.

**Table 3.14** Principal sources of irrigation in Uttar Dinajpur District, 2011

| Name of the C.D. Blocks | Principal Sources of irrigation 2011 | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Tank | *River Lift Irrigation (RLI) | *Deep Tube wells (DTW) | Surface flow and storage system | Shallow tube wells (STWs) | Govt. shallow tube wells (TWs) | Total units |
| Chopra | 208 | 6 | 2 | 20 | 3,000 | 217 | 3,453 |
| Islampur | - | 6 | 19 | 80 | 4,500 | 376 | 4,981 |
| Goalpokher-I | - | 8 | 17 | 90 | 4,225 | 1,868 | 6,208 |
| Goalpokher-II | - | 9 | 12 | 110 | 4,895 | 968 | 5,994 |
| Karandighi | - | 15 | 25 | 151 | 6,600 | 1,268 | 8,059 |
| Raiganj | - | 16 | 14 | 195 | 10,896 | 1,776 | 12,897 |
| Hemtabad | 10 | 11 | 18 | 40 | 4,000 | 1,152 | 5,231 |
| Kaliaganj | 1,200 | 11 | 49 | 100 | 5,417 | 1,308 | 8,085 |
| Itahar | 1,960 | 28 | 33 | 120 | 7,962 | 1,476 | 11,579 |

Source: i. * District Statistical Hand Book 2011, Bureau of Applied Economics & Statistics, Government of West Bengal, Uttar Dinajpur
ii. Assistant Engineering, (Agriculture mechanization), Jalasampad Bhawan, Government of West Bengal, Karnojora, Uttar Dinajpur.

The situation of surface flow and storage system, shallow tube wells (STWs), deep tube wells as well as Government shallow tube wells (TWs), in Chopra Block are 20, 3000, 217 in number and in Hemtabad Block are 40, 4000 and 1152 in number respectively (table 3.14).

Therefore, on the basis of the above discussion, it is noticed that the coverage of irrigation is not homogenous in the district due to the non-flat topography in some blocks that are found in the northern part of the district, variation in water level, high cost of digging canals and sinking of tube wells and major blocks of the district that is found in the south-eastern part of the district have recorded high extent of irrigation, low cost of digging of canals as well as water bodies and sinking of tube wells, Government shallow tube wells are available and development of technology have recorded high status of irrigation of the study area. It is also found that the central part of the district has recorded the medium status of irrigation. For a better understanding of irrigation expansion area in the district and considered the actual growth rate of irrigation area shown in table 3.15.

**Table 3.15** Growth of area under irrigation of different block in Uttar Dinajpur District (1971-2011)

| Name of the C.D. Blocks | Irrigation area in hectares | | | Growth of irrigation area (%) (1971-2011) |
|---|---|---|---|---|
| | 1971 | 1991 | 2011* | |
| Chopra | 12.94 | 22.40 | 13,316 | 102,809 |
| Islampur | 16.18 | 2164.00 | 15,110 | 93,287 |
| Goalpokher-I | 99.16 | 2224.08 | 16,227 | 16,265 |
| Goalpokher-II | 278.41 | 3837.93 | 17,736 | 6,271 |
| Karandighi | 469.42 | 11878.40 | 19,761 | 4,110 |

| | | | | |
|---|---|---|---|---|
| Raiganj | 1423.65 | 11174.55 | 22,176 | 1,458 |
| Hemtabad | 2107.56 | 2970.46 | 13,507 | 541 |
| Kaliaganj | 1732.83 | 3445.33 | 15,651 | 804 |
| Itahar | 1326.53 | 10010.00 | 18,107 | 1,265 |
| **Uttar Dinajpur** | **7,466.68** | **4,77,27.15** | **1,51,591** | **1,931** |

Source: i. Computed from Census of India (1971-2011)

ii. * Water Resources Development Directorate (WRDD), Jalsampad Bhawan, Government of West Bengal, Karnojora, Uttar Dinajpur.

The introduction of new technology in the irrigation system, use of other inputs in the irrigation system and as a result, the change of irrigation area has increased each and every block from the year 1971 to 2011 in the district. From the table 3.15, it is revealed that in the year 1971 total irrigated area in Uttar Dinajpur District was 7,466.68 hectares which increased at a tremendous rate and reached 47,727.15 hectares in 1991. This constitutes 539.20 per cent net increase between 1971 and 1991. But between 1991 and 2011, it has increased to 217.62 per cent from the base year 1991. On a district basis, the irrigated area expanded by an average per annum of 26.96 per cent from 1971 to 1991. The rate of expansion began increasing per annum 15.88 per cent from the year 1991 to 2011. At present levels of population growth in recent times, the slower expansion in irrigated areas is resulting in an unheard decline in the peak amount of irrigated lands. Because, irrigation related problems are the result of a distorted macro economy which despite providing operating subsidies, renders farming unprofitable and results in repeated farms over long times. The overall performance of many irrigation projects is disappointing in the district between 1991 and 2011 (Biswas, 1990). This trend of irrigation is to develop a comprehensive system of irrigation according to the population pressure and environmental conditions of the district.

### 3.7.1 The actual growth of irrigation area in Uttar Dinajpur District (1971-2011)

The growth of the high irrigation area is 102,809 per cent (table 3.15) between 1971 and 2011 recorded in Chopra Block. But very low growth has been found in Hemtabad Block (541 per cent). For the better appreciative discussion, depending on the growth of irrigation area for the period of the study of blocks in Uttar Dinajpur District between 1971 and 2011 a chart has been categorized and findings are in table 3.16.

**Table 3.16** Status of Irrigation area in Uttar Dinajpur District (1971-2011)

| Irrigation Category | Irrigation growth index | No. of C.D. Blocks | Name of the C.D. Blocks |
|---|---|---|---|
| Low | <1000 | 2 | Hemtabad and Kaliaganj |
| Medium | 1000-2000 | 2 | Raiganj and Itahar |
| High | >2000 | 5 | Chopra, Islampur, Goalpokher-I, Goalpokher-II and Karandighi |

Source: Computed by the researcher from table 3.15

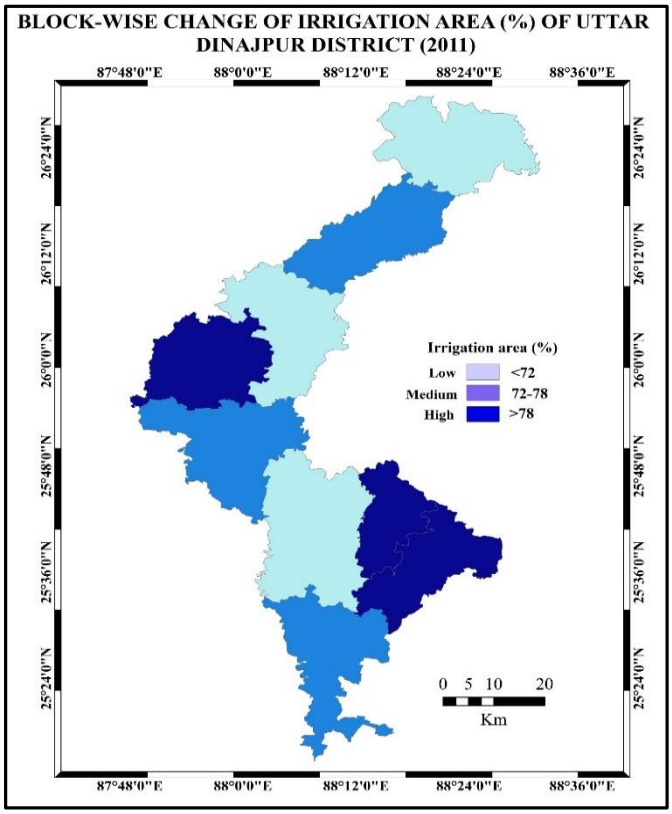



**Figure 3.10** Area under irrigation in Uttar Dinajpur District, 2011

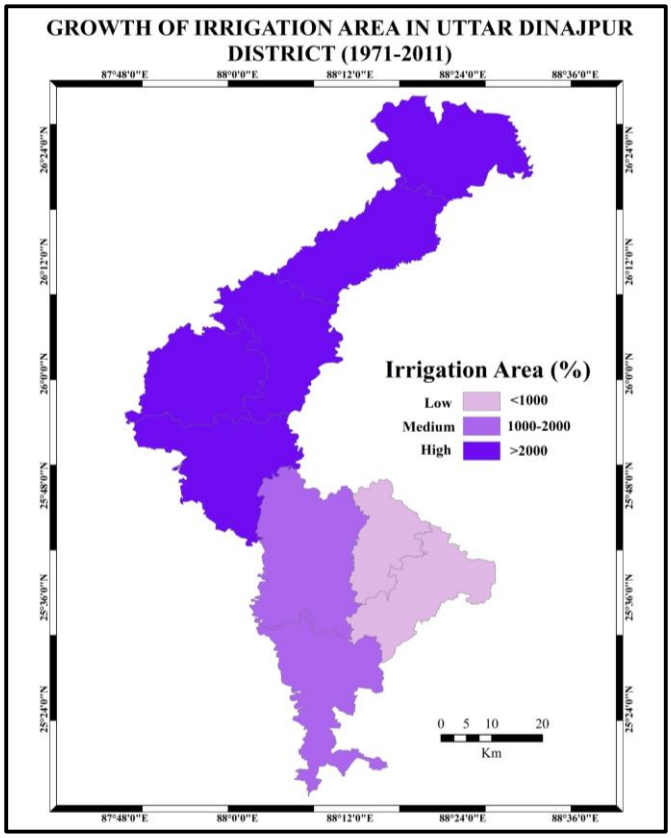



**Figure 3.11** Growth of irrigation area in Uttar Dinajpur District (1971-2011).

**i. Low growth irrigation area**

In the study area, the low growth irrigation zone is limited to two blocks namely Hemtabad (541 per cent) and Kaliaganj (804 per cent) with an irrigation index value below 1,000 per cent. This zone lies in the southern part of the district (figure 3.11). The causes of low growth of irrigation areas are poor irrigation facilities and low fertility of lands.

**ii. Medium growth irrigation area**

The medium growth irrigation zone is observed in two blocks namely Raiganj (1,458 per cent) and Itahar (1,265 per cent) with irrigation growth index ranges between 1,000-2,000 per cent (table 3.17). This zone lies in the south-middle part of the district (figure 3.11).

**iii. High growth irrigation area**

In the study area, a high growth irrigation area is observed in five blocks namely Chopra (102,809 per cent), Islampur (93,287 per cent), Goalpokhar-I (16,265 per cent), Goalpokher-II (6,271 per cent) and Karandighi (4,110 per cent). The high irrigation zone lies in the northern part of the district with a growth value of above 2,000 per cent. The causes of high growth irrigation are technological improvements, electrification at every rural village for use of pumps, tube well, etc, and single cropped land converted to multi-cropped land.

### 3.7.2 Impact of irrigation in Uttar Dinajpur District

Irrigation is the procedure of supplying water to the land at standard intervals and its uses and distribution of water on top of the land. It helps to grow crops in any region. The impacts of irrigation in Uttar Dinajpur District are varied due to several reasons. The major impacts are on land use pattern change, the intensity of cropping, yield rates of major crops, changes in the cropping pattern and production of food grains, etc.

**a) Land use pattern change**

Owing to the development of irrigation, some categories of land are converted to the gained area and some are lost. Development of irrigation and its spread make possible renovation of wasteland and permanent pastures, an increase in net sown area, the decline in fallow and current fallow land. The district shows the increasing percentage of net sown area and land under miscellaneous tree crops and groves but declines in the cultivable waste land, current fallow and land under fallow other than fallow. As a result, the amount of net sown area has increased from 257.34 thousand hectares to 276.73 thousand hectares during 1993-94 and 2013-14 respectively (table 3.18). In the year 2013-14 the net sown area accounts for 88.56 per cent of the total reporting area of the district. And it gives a clear picture that there is limited scope for its further expansion. While land under miscellaneous uses like tree crops and groves

has increased from 2.91 thousand hectares in 1993-94 to 3.47 thousand hectares in 2013-14, on the other hand, the highest decrease is recorded in current fallow land, which has decreased from 7.71 to 0.15 thousand hectares during 1993-94 - 2013-14. But fallow other than fallow has decreased from 0.20 thousand hectares to 0.10 thousand hectares during 1993-94 to 2013-14 respectively and cultivable waste land, which has also decreased from 0.29 thousand hectares to 0.07 thousand hectares between the year 1993-94 to 2013-14 respectively. The major causes of the decline in the cultivable wasteland, current fallow and fallow other than fallow are- slowly but steadily tea plantation is increasing in the district which may cause reduction in the area, development of irrigation which facilitates the reclamation of fallow and current fallow land. As a result, the expansion of the net area of net sown area day-by-day in the district is seen.

**Table 3.17** Changing land use pattern (1993-94 to 2013-14)
('000 hectares)

| Years | Culturable waste land | Current Fallow | Fallow other than current fallow | Land under Misc. Tree crops & groves | Net area sown |
|---|---|---|---|---|---|
| 1993-94 | 0.29 | 7.71 | 0.20 | 2.91 | 257.34 |
| 1998-99 | 0.18 | 2.63 | 0.23 | 2.46 | 189.80 |
| 2003-04 | 0.13 | 4.47 | 0.62 | 3.23 | 272.58 |
| 2008-09 | 0.06 | 0.30 | 0.50 | 2.40 | 276.80 |
| 2013-14 | 0.07 | 0.15 | 0.10 | 3.47 | 276.73 |

Source: Office of the Bureau of Applied Economics & Statistic, Government of West Bengal, Karnajora, Uttar Dinajpur.

### b) Change of productivity in major crops

All of the crops that have been tabulated in table 3.18; they were positively changed during the study period (i.e. 1993-94 to 2013-14). Increasing of crops productivity is directly related to the irrigation intensity. In the last few decades yield rates have increased because of the development of irrigation, farmers' adoption of HYV seeds, and a huge amount of use of chemical fertilizers and pesticides and modernization in agriculture. In the district, rice is an important crop that has been a 1$^{st}$ ranking crop. The productivity of rice has increased from 1,562 kg/ha to 2,530 kg/ha in the year 1993-94 to 2013-14. The second important crop is wheat whose productivity was 1891 kg/ha in 1993-94 and it has increased to 2383 kg/ha in 2013-14. Maize recorded the highest positive change from 912 kg/ha in 1993-94 to 5,218 kg/ha in 2013-14 which is about 6 times increase in 20 years. Jute and pulses productivity has also increased 1,337 kg/ha and 409 kg/ha during 1993-94 to 2,338 kg/ha and 761 kg/ha in 2013-14 respectively.

**Table 3.18** Change in yield rates of major crops in Uttar Dinajpur District.
(Kilogram per hectare)

| Years | Rice | Wheat | Maize | Jute | Pulses |
|---|---|---|---|---|---|
| 1993-94 | 1,562 | 1,891 | 912 | 1,337 | 409 |
| 1998-99 | 1,938 | 2,241 | 4,013 | 1,440 | 482 |
| 2003-04 | 2,368 | 2,019 | 4,310 | 1,854 | 508 |
| 2008-09 | 2,432 | 2,694 | 4,956 | 2,160 | 553 |
| 2013-14 | 2,530 | 2,383 | 5,218 | 2,338 | 761 |

Source: Office of the Bureau of Applied Economics & Statistics, Government of West Bengal, Karnajora, Uttar Dinajpur.

### c) Change of production of major crops

The changes are not bound in cropping intensity and yield rate in the district. Irrigation impact observed the positive change of production in Uttar Dinajpur District. The causes of positive change of production are the development of irrigation as well as modernization in agriculture and many irrigation schemes have been taken by the WRDD (Water Resources Development Directorate) in the district. Not only that, most of the land has been brought under two or three crops. So, the net cropped area and double crop area has increased.

**Table 3.19** Production of major crops in Uttar Dinajpur District.
('000 tonnes)

| Years | Rice | Wheat | Maize | Jute | Pulses |
|---|---|---|---|---|---|
| 1993-94* | 405.60 | 51.00 | 0.15 | 223.60 | 7.30 |
| 1998-99 | 489.20 | 65.00 | 0.10 | 476.60 | 6.90 |
| 2003-04 | 700.00 | 93.60 | 21.30 | 666.50 | 4.20 |
| 2008-09 | 683.50 | 98.20 | 65.50 | 609.60 | 1.50 |
| 2013-14 | 573.83 | 89.30 | 224.70 | 578.10 | 2.70 |

Source: i. *Office of the Directorate of Agriculture, Government of West Bengal, Uttar Dinajpur
ii. Office of the Bureau of Applied Economics & Statistics, Government of West Bengal, Karnajora, Uttar Dinajpur.

From the table 3.19 it is revealed that in the year 1993-94 to 2013-14, the total production of rice has increased from 405.60 thousand tonnes to 573.80 thousand tonnes respectively. While the production of wheat was 51.0 thousand tonnes in 1993-94 it rose to 89.30 thousand tonnes in 2013-14. The next important crop was maize which had a tremendous production increase of 0.15 thousand tonnes to 224.70 thousand tonnes in 1993-94 and 2013-14 respectively. The production of pulses has declined during the study period. It has decreased by 7.3 thousand tonnes in 1993-94 to 2.7 thousand tonnes in 2013-14.

From the foregoing discussion, it becomes evident that the study area has witnessed significant development of irrigation which caused the change in land use patterns over the last few decades. Available irrigation facilities led to the expansion of the net sown area, changes in crop production per hectare, a positive change of yield rates and intensity of land uses. Thus, the future development of irrigation is necessary that will help the growth of agriculture in the

northern part as well as the whole part of the district. Present yield rates and production of rice should be altered and be placed by crops that require less water. Therefore, farmers should be encouraged to grow water resistant and valuable crops like; jute, oilseeds, pulses, etc. in at least 35 per cent of the total cropped area.

**d) Change of intensity of cropping**

Cropping intensity refers to the total cropped area as per cent to the net sown area in a region. Cropping intensity depends on different factors like; sufficient water supply, suitable climate, improved farming practices and soil fertility. In the district, the intensity of cropping has increased in all the blocks in two decades.

**Table 3.20** Cropping intensity of Uttar Dinajpur District.

| Years | Gross cropped area ('000 hectares) | Net sown area ('000 hectares) | Cropping intensity (%) |
|---|---|---|---|
| 1993-94* | 407.900 | 251.210 | 162.37 |
| 1998-99 | 421.600 | 257.346 | 163.82 |
| 2003-04 | 481.500 | 272.580 | 176.64 |
| 2008-09 | 555.900 | 276.990 | 200.69 |
| 2013-14 | 583.450 | 276.730 | 210.83 |

Source: i. *Computed by the author from different sources
ii. Office of the Bureau of Applied Economics & Statistics, Government of West Bengal, Karnajora, Uttar Dinajpur.

It is observed from the table 3.20 that, in Uttar Dinajpur District during 1993-94, cropping intensity was 162.37 per cent i. e. 407.9 thousand hectares area under gross cropped area and about 251.2 thousand hectares under the net sown area. But the cropping intensity has increased in the year 2013-14 (i.e. 210.83 per cent) in the district. The causes of increasing intensity are mechanization in the agricultural sector, development of irrigation systems as well as electrification of all blocks (rural area), increase use of chemical fertilizers and pesticides, the high price of crops. Therefore, farmers are interested to grow two and more crops in a year. Not only that, but the district has also seen a net 48.46 per cent positive increase of cropping intensity in the study period.

**Table 3.21** Some major impact and their mitigation of irrigation in Uttar Dinajpur District at a glance.

| Problems | Mitigation Measures |
|---|---|
| Salinization | It delivers drainage as well as dumping of water to evaporation ponds or rivers if the quality of river flow is adversely affected by drainage water. |
| Water logging | Supply water for leaching as a specific action. |
| Soil Acidification | Regulation of irrigation administration structure to ensure enough income to reserve both irrigation and drainage construction. |
| Weaker communal infrastructures | Consider markets, financial facilities and agronomic extension in conjunction with planned irrigation and drainage system changes. |

| | |
|---|---|
| | Confirm that agronomic amplification does not stop other financial events, such as household vegetables and fodder trees for firewood. |
| Irrigation water quality reduction | Control manufacturing improvement and monitor irrigation water quality. |
| Destruction to downstream ecosystems due to water amount and quality | Designate land owing to flood plains, swamplands, water huts and drainage water disposal. |

Source: Environmental impact assessment of irrigation and drainage projects, pp. 152-154

### 3.8 Soil fertility and productivity

Soil fertility is a characteristic of soil that supports abundant plant life (R. Kumar., 2009). It is an element of overall soil productivity that deals with its available nutrients position and its capability to provide nutrients out of its personal reserves and throughout external applications for crop production. In any agricultural operation, soil is of the utmost importance as it is the cradle for all crops and plants. The top soil having an average depth of about 15-20 cm on the face of the land is the natural body of soil on which plants develop and the farming activities flourish. The standard of living of the people dependent on agriculture is often determined by the soil fertility and productivity (Hussain, 2005). In the district generally two types of soil fertility found in soil, one is inherent or natural fertility and another is acquired fertility. The present study discussed inherent fertility. Among the soil nutrients Nitrogen (N), Phosphorus ($P_2o_5$), Potassium ($K_2o$), Sulphur (S), Manganese (Mn), Iron (Fe), Organic Carbon (Oc) and $P^H$ (Potentiality of hydrogen) are essential for the normal growth of plant and yield of crops. On the basis of the survey conducted by the Office of the Agricultural Chemist, Soil Testing Laboratory (STL), Uttar Dinajpur District, a total of 48,465 samples were tested all over the district and its average value of the various blocks has been determined and presented in the table 3.22 (Appendix IIIa).

From the table 3.22, it is revealed that the nitrogen value in the district ranges from 189.20 to 546.60 kg per hectare which is not suitable for paddy and wheat. Most of the crops are suited to the ranges between 150-300 kg per hectare of nitrogen. The organic substance content of soil plays a dominant part in crop production by interacting with other nutrients. But the potassium (average 86.70 to 311.70 kg per ha) and phosphorus (average 125.40 to 323.30 kg per ha) are micro nutrients for crop production i.e. low to the medium category in the soil of the district. Sulphur (average 7.95 to 52.50 kg per ha) is also a micronutrient for crop growth. Although as a micronutrient, sulphur has no direct impact on the plant's growth. The situation

of sulphur is medium to high in the majority of the blocks in the district. On the other hand, the situation of $P^H$ in the district is the acidic type. Soil $P^H$ is a measure of the soil's relative acidity. The optimal $P^H$ for a plant varies with organic matter content and plant type and plant nutrient availability is strongly tied to the $P^H$ in the soil solution. The $P^H$ value of soil in the district is suitable for paddy, potato, maize, cauliflower, ginger, mustard, etc.

### 3.8.1 Availability of nitrogen (N)

Nitrogen is a chemical form that can be readily absorbed by plant roots. Available nitrogen content in the study area varied from 189.20-546.60 with an average of 367.90 kg per hectare. Nearly all of the nitrogen found in soils is an integral part of organic matter. In fact, the amount of organic matter in soil can be estimated by measuring the total amount of nitrogen. The proportion of carbon to nitrogen in most cultivated soils ranges between 10 and 12, a rather thin range considering the wide diversity of soils (Morachan, 1978). It is the fourth plant nutrient taken up by the different plants in maximum quantity next to carbon, oxygen and hydrogen (Sanchez, 1976; Mengel and Kirkby, 1987), and present in the soil in appropriate proportion for the growth of plants. Plants require more nitrogen (N) than the other nutrients but a small portion of nitrogen is available in soil to the plants. Not only is that, about 98 per cent of the nitrogen in soil in organic form.

**Table 3.23** Status of nitrogen (N)

| Sl. No. | Nitrogen class | Status of nitrogen (kg/ha) | Area in hectares | % of the total area |
|---|---|---|---|---|
| 1 | Low | < 280 | 31191.10 | 9.93 |
| 2 | Medium | 280-450 | 157188.00 | 50.05 |
| 3 | High | >450 | 125623.00 | 40.02 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur.

The soil sample of district is classified on the basis of the presence of nitrogen content in soil into four categories; they are low (<280 kg/ha), medium (280-450 kg/ha) and high (>450 kg/ha) which are summarized in the table 3.23. Availability of nitrogen content status indicated that soils in about 9.93 per cent area of the district contained low nitrogen status. But medium availability of soils with respect to nitrogen content is about 50.05 per cent. On the other side, high statuses of soils with respect to nitrogen were mapped in 40.02 per cent area of the district (figure 3.12).

### 3.8.2 Availability of phosphorus (P)

Phosphorus exists in soils in both forms like; inorganic and organic. Phosphorus is an important micronutrient of the plant which makes up about 0.20 per cent of a plant's dry weight. It is a

component of key molecules such as nucleic acids, phospholipids and ATP consequently; plants cannot grow without a reliable supply of this nutrient.

Phosphorus is also connected in controlling key enzyme reactions and in the regulation of metabolic pathways (Theodorou and Plaxton, 1993; Schachtman, et al, 1998). In many agricultural systems in which the application of phosphorus to the soil is necessary to ensure plant productivity, the recovery of applied phosphorus by crop plants in a growing season is very low because in the soil more than 80 per cent of the phosphorus becomes immobile and unavailable for plant uptake because of absorption, precipitation or conversion to the organic form (Holford, 1997). Phosphorus is very important at flowering for plant and pod formation stages of crop (Singh, et al, 1991) and its introduction to growth the modulation, N2-fixation and N substances of the kernel and foliage (Singh, 1996).

From the soil sample of the study area, it may be classified on the basis of the existence of phosphorus in soil into four categories; they are low (<45 kg/ha), medium (45-90 kg/ha), high (90-190 kg/ha) and very high (>190 kg/ha) which are summarized in the table 3.24.

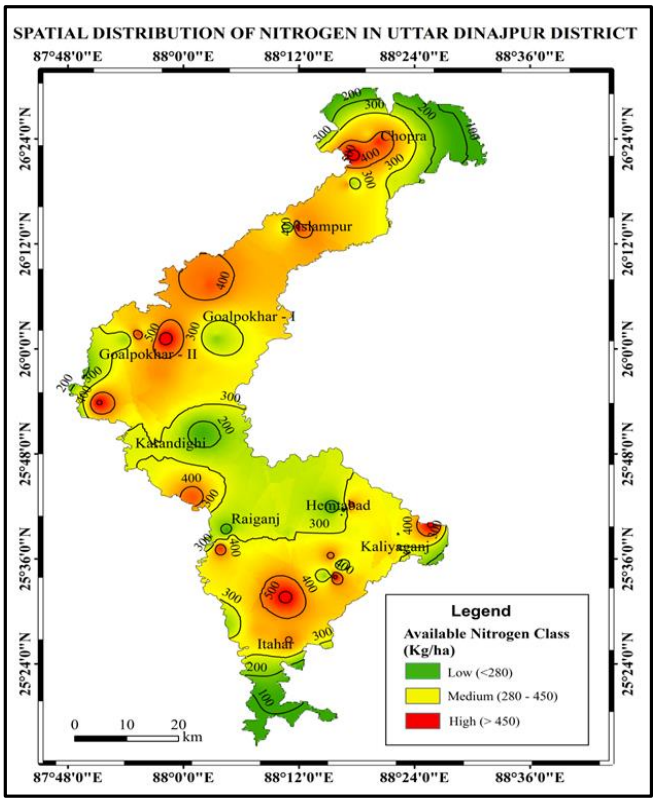



**Figure 3.12** Nitrogen status in Uttar Dinajpur District.

**Table 3.24** Status of phosphorus (P)

| Sl. No. | Phosphorus class | Status of phosphorus (kg/ha) | Area in hectares | % of the total area |
|---|---|---|---|---|
| 1 | Low | < 45 | 42,649.75 | 13.58 |
| 2 | Medium | 45-90 | 2,38,420.90 | 75.93 |
| 3 | High | 90-190 | 31,120.66 | 9.91 |

| | | | | |
|---|---|---|---|---|
| 4 | Very high | >190 | 1,808.70 | 0.57 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur

Phosphorus content status indicated that about 13.58 per cent area of the district contained low phosphorus status. The medium availability of soils with respect to phosphorus content is about 75.93 per cent. But high and very high statuses of soils with respect of phosphorus were mapped in 9.91 per cent and 0.57 per cent area of the district respectively (figure 3.13).

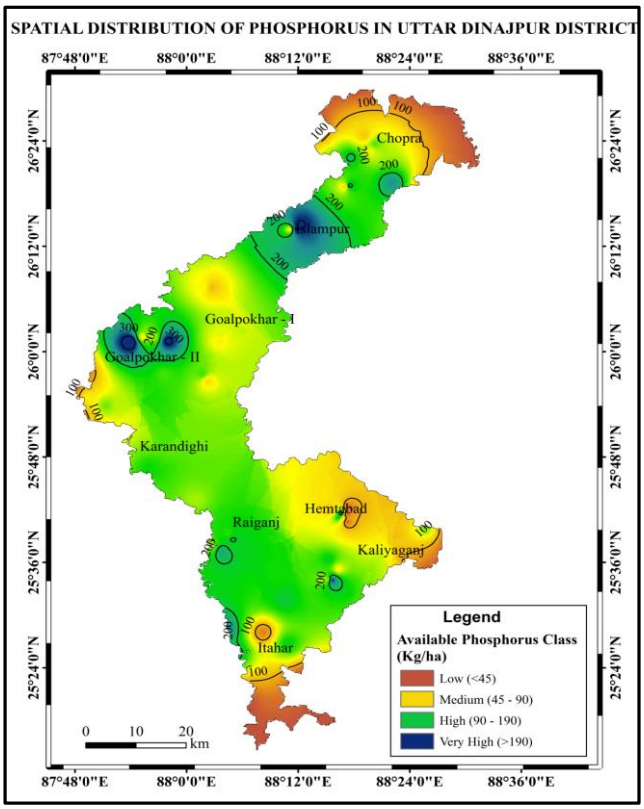



**Figure 3.13** Phosphorus status in Uttar Dinajpur District.

### 3.8.3 Availability of Potassium (K)

Potassium is one of the most important plant nutrient elements out of three major nutrients (NPK). Out of all mineral nutrients, potassium (K) plays a particularly critical role in plant growth and metabolism and it contributes greatly to the survival of plants that are under various biotic and abiotic stresses. The importance of potassium fertilizer for the formation of crop production and its quality is known. As a consequence, potash consumption has increased dramatically in most regions of the world (Pettigrew, 2008; Wang, 2013). On the other hand, potassium is important for plants because it participates in the activation of a large number of enzymes that are involved in the physiological process of plants. It controls the water economy and provides resistance against a number of pests, diseases and environmental stresses (Orlov, 1992).

Not only that, potassium is particularly important in helping plants adjust to ecological stresses. Good potassium sustenance is linked to developed drought tolerance, developed winter-hardiness, and improved resistance to certain fungal diseases and superior tolerance to insect pests. It also enriches the quality of flowers, fruits and vegetables by developing flavour and colour and strengthening stems (Brady and Weil, 2002).

**Table 3.25** Status of potassium (K)

| Sl. No. | Potassium class | Status of potassium (kg/ha) | Area in hectares | % of the total area |
|---|---|---|---|---|
| 1 | Low | < 200 | 37202.40 | 11.84 |
| 2 | Medium | 200-350 | 204230.00 | 65.04 |
| 3 | High | >350 | 72607.40 | 23.12 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur.

From the present study of the study area it may be classified on the basis of the existence of potassium in soil into four categories; they are low (<200 kg/ha), medium (200-350 kg/ha) and high (>350 kg/ha) which are summarized in table 3.28. Potassium content status indicated that about 11.84 per cent area of the district contained low potassium status. The medium availability of soils with respect to potassium content is about 65.04 per cent. But high statuses of soils with respect of potassium were mapped in 23.12 per cent area of the district respectively (figure 3.14).

### 3.8.4 Availability of Sulphur (S)

Sulphur is a non-metallic ingredient that occurs in several forms. It is usually absorbed from the soil as the sulphate ion, in which form it is readily mobile within the plant. Not only that, sulphur in plant compounds may be reconverted to the sulphate form and re-utilization in the formation of other sulphur containing complexes in a different part of the plant (Jordan and Reisenauer, 1957). It increases nodulation and pod yield besides decreasing the incidence of diseases and is as essential as phosphorus for oilseed crops. Sulphur growths chlorophyll and reductions chlorosis in calcareous soil (Singh, et al, 1990).

The soil sample of the study area is classified on the basis of the presence of sulphur content in soil into four categories; they are low (<10 mg/kg), medium (10-15 mg/kg), high (15-50 mg/kg) and very high (>50 mg/kg) which are summarized in the table 3.27. The availability of sulphur content status indicated that soils in about 68.77 per cent area of the district contained low sulphur status. But medium availability of soils with respect of sulphur content is about 31.17 per cent. On the other side, high and very high statuses of soils with respect of sulphur were mapped in 0.05 per cent and 0.01 per cent area of the district respectively (figure 3.20).

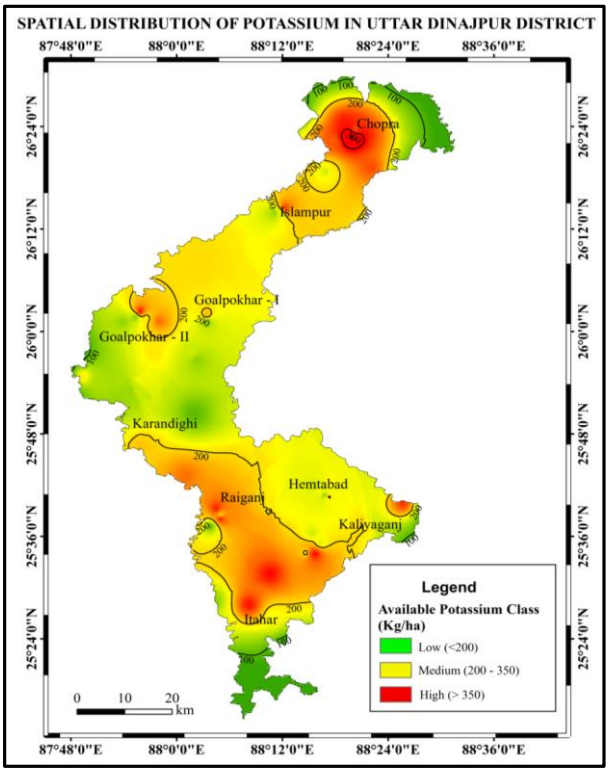



**Figure 3.14** Potassium status in Uttar Dinajpur District.

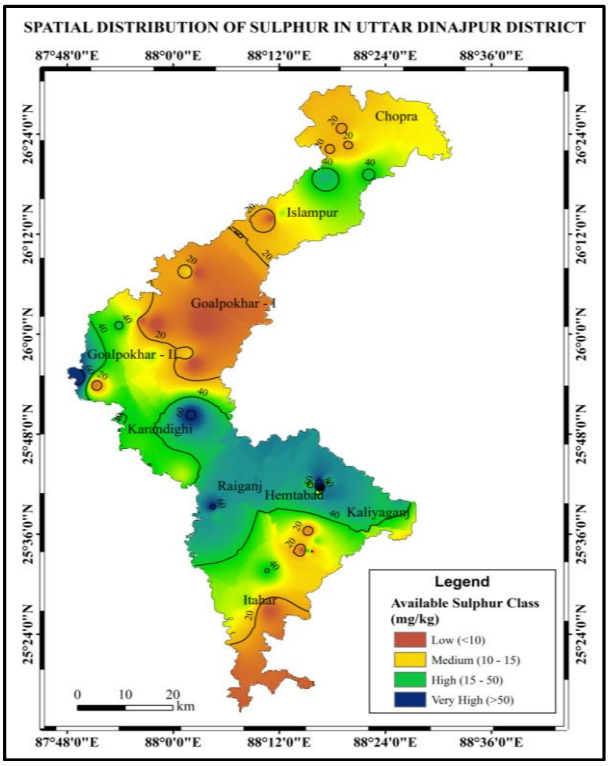



**Figure 3.15** Sulphur status in Uttar Dinajpur District.

**Table 3.26** Status of sulphur (S)

| Sl. No. | Sulphur class | Status of sulphur (mg/kg) | Area in hectares | % of the total area |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | Low | <10 | 215951.60 | 68.77 |
| 2 | Medium | 10-15 | 97869.40 | 31.17 |
| 3 | High | 15-50 | 127.62 | 0.05 |
| 4 | Very high | >50 | 53.17 | 0.01 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur.

### 3.8.5 Availability of Manganese (Mn)

Manganese (Mn) is an essential plant mineral nutrient and it is playing a key role in several physiological processes, particularly photosynthesis. Manganese deficiency is a widespread problem, most often occurring in sandy soil, organic soils with a pH above 6 and heavily weathered, tropical soils. It is typically worsened by cool and wet conditions (Alloway, 2008). Manganese has comparatively low phloem mobility in plants; as a result, typical leaf symptoms of manganese scarcity primary develop in younger leaves.

It is observed by Benac (1976) that the nutrient solution with manganese concentration 20 ppm had stunted growth of plants. However, Parker and Walker (1986) stated that the critical manganese concentrations in leaves were 13-15 ppm from seven to thirteen weeks next the sowing of crops.

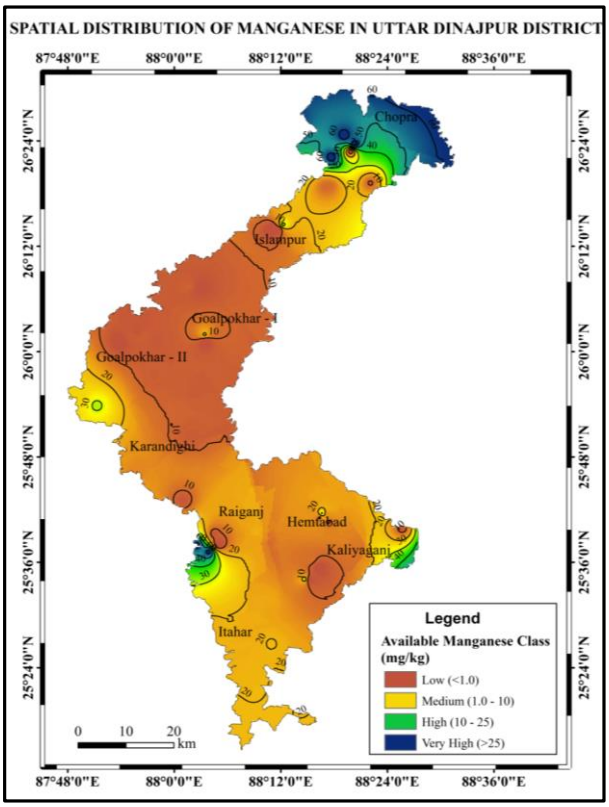



**Figure 3.16** Manganese status in Uttar Dinajpur District.

From the present study of the study area, it may be classified on the basis of the existence of manganese in soil into four categories; they are low (<1.0 mg/kg), medium (1.0-10 mg/kg),

high (10-25 mg/kg) and very high (>25 mg/kg) which are summarized in the table 3.28. Manganese content status indicated that about 58.12 per cent area of the district contained low manganese status. The medium availability of soils with respect to manganese content is about 29.78 per cent. But high and very high statuses of soils with respect of manganese were mapped in 3.41 per cent and 8.69 per cent area of the district respectively (figure 3.16).

**Table 3.27** Status of manganese (Mn)

| Sl. No. | Manganese class | Status of manganese (mg/kg) | Area in hectares | % of the total area |
|---|---|---|---|---|
| 1 | Low | < 1.0 | 182519.70 | 58.12 |
| 2 | Medium | 1.0-10 | 93520.25 | 29.78 |
| 3 | High | 10-25 | 10689.50 | 3.41 |
| 4 | Very high | >25 | 27270.54 | 8.69 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur.

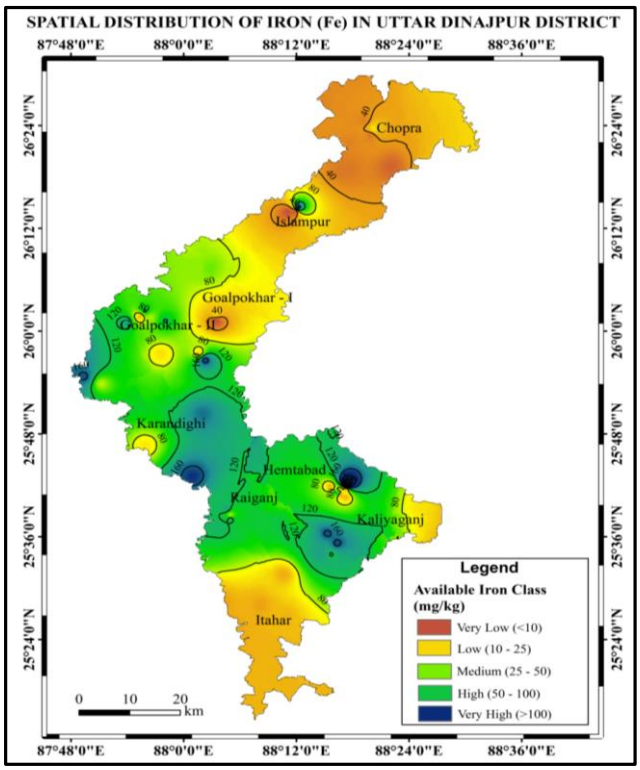



**Figure 3.17** Iron status in Uttar Dinajpur District.

### 3.8.6 Availability of Iron (Fe)

Iron is the fourth most abundant element in earth crust and soil, still, its deficiency is most widespread in the world mainly due to its availability in root zone rather than abundance. About $^{1}/_{3}$ of the soils in the world are calcareous wherever iron deficiency is the greatest common problem (Vose, 1982). Moreover, iron is not only available in neutral to alkaline soils, rendering plant life iron deficient despite its abundance (Mori, 1999). Iron limitation reasons the decline of various photosynthetic constituents, containing the Fe-S protein ferredoxin (Fd), which is involved in important oxidoreductive pathway of chloroplasts (Tognetti, et al, 2007).

But iron deprived plants usually progress intervened chloric symptoms in new leaves as well as poor root creation and when severe, the insufficiency leads to growth retardation, stasis and death (Kobayashi, et al, 2003).

From the study area, sample soil on the basis of iron content in soil is classified into four categories; they are very low (<10 mg/kg), low (10-25 mg/kg), medium (25-50 mg/kg), high (50-100 mg/kg) and Very high (100) which are presented in the table 3.29. Availability of iron content status indicated that soils in about 31.71 per cent and 23.21 per cent area of the district contained very low and low iron status respectively. But medium availability of soils with respect to iron content is about 30.73 per cent. On the other hand, high and very high status of soils with respect to iron were mapped in 14.18 per cent and 0.17 per cent area of the district respectively (figure 3.17).

**Table 3.28 S**tatus of iron (Fe)

| Sl. No. | Iron class | Status of iron (mg/kg) | Area in hectares | % of the total area |
|---|---|---|---|---|
| 1 | Very Low | < 10 | 99579.20 | 31.71 |
| 2 | Low | 10-25 | 72905.80 | 23.21 |
| 3 | Medium | 25-50 | 96473.70 | 30.73 |
| 4 | High | 50-100 | 44509.50 | 14.18 |
| 5 | Very high | >100 | 531.76 | 0.17 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur.

### 3.8.7 Availability of Organic Carbon (OC)

Changes in soil organic carbon (SOC) concentration affect soil physical properties. An increase in soil organic carbon promotes macro aggregation, reduces soil compaction risks and growths water retention volume (Shapiro, et al, 2013). It releases nutrients for plant improvement, promotes the creation of plants and is a precaution against damaging substances. Soil organic carbon assistances to sustain soil fertility by improving soil construction, retention of mineral nutrients, growing water holding capacity, water infiltration, drainage capability, aeration and root penetration and also helps to growth the quantity of soils flora (Havlin, et al, 2010). Detritus resulting from plants and animal senescence are the main sources of organic carbon in soil.

**Table 3.29** Status of Organic Carbon (OC)

| Sl. No. | Organic carbon class | Status of organic carbon (%) | Area in hectares | % of the total area |
|---|---|---|---|---|
| 1 | Low | < 0.50 | 109605.00 | 34.90 |
| 2 | Medium | 0.50-0.75 | 167887.00 | 53.47 |
| 3 | High | >0.75 | 36508.70 | 11.63 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur.

From the present study of the study area, it may be classified on the basis of the existence of organic carbon in soil into four categories; they are low (<0.50 per cent), medium (0.50-0.75

per cent) and high (>0.75 per cent) which is summarized in table 3.30. Organic carbon content status indicated that about 34.90 per cent area of the district contained low organic carbon status. The medium availability of soils with respect to organic carbon content is about 53.47 per cent. On the other hand, high statuses of soils with respect to organic carbon were mapped in 11.63 per cent area of the district respectively (figure 3.18).

### 3.8.8 Availability of Potential of Hydrogen (pH)

Soil pH is very important because it directly affects soil nutrient availability. Besides, soil pH is an essential property of soil from the perspective of agro-ecological system and it is limited by clay minerals, organic matter and oxides of Al, Fe, Ca and Na (Thomas, 2006). On the other hand, it controls other properties of soil (Brady and Weil, 1999). Soil pH, in particular, can be considered a key variable due to its influence on many other soil properties and processes affecting plant growth. Indeed, microorganism activity, as well as nutrients solubility and availability, are some of the most important processes that depend on pH. For example, in acidic soils, maximum micronutrients are more accessible to plants than in natural-alkaline soils, normally favouring plant progress (Loncaric, et al, 2008; Gentili, et al, 2018).

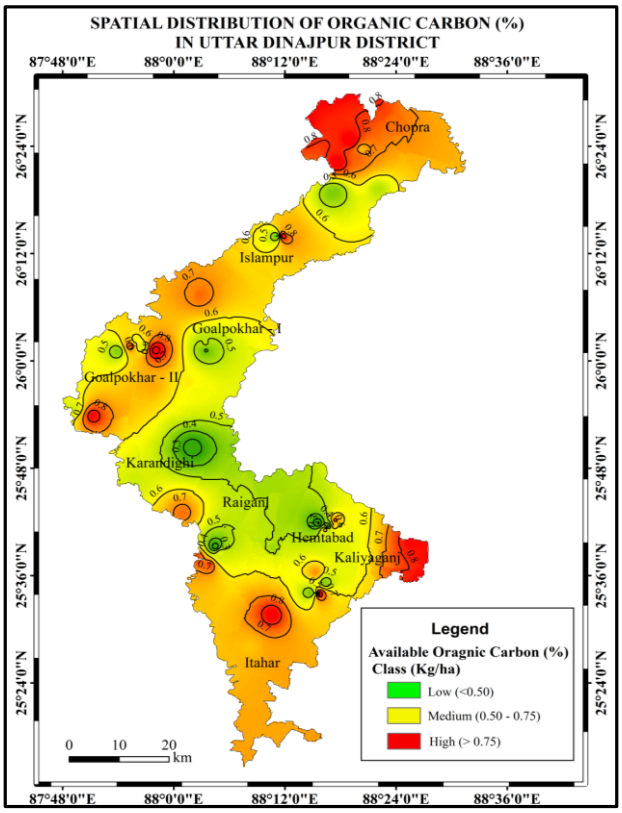



**Figure 3.18** Organic Carbon status in Uttar Dinajpur District.

**Table 3.30** Status of pH

| Sl. No. | pH class | pH scale | Area in hectares | % of the total area |
|---|---|---|---|---|
| 1 | Very strongly Acidic | < 5.0 | 2234.13 | 0.71 |
| 2 | Strongly Acidic | 5.1 to 5.5 | 33152.08 | 10.55 |
| 3 | Moderately Acidic | 5.6 to 6.0 | 233517.80 | 74.36 |
| 4 | Slightly Acidic | > 6.5 | 45095.96 | 14.36 |

Source: Compiled by the researcher from soil testing laboratory data, Raiganj, Uttar Dinajpur.

From the sample soil on the basis of pH content in soil it may be classified into four categories; they are very strongly acidic (4.5 to 5.0), strongly acidic (5.1 to 5.5), moderately acidic (5.6 to 6.0) and slightly acidic (6.1 to 6.5) which is presented in table 3.31. Very strongly acidic pH content status in soils is in about 0.71 per cent area of the district. But strongly acidic availability of soils with respect to pH content is about 10.55 per cent. On the other hand, the moderately acidic and slightly acidic status of soils with respect to pH was mapped in 74.36 per cent and 14.36 per cent area of the district respectively (figure 3.19).

### 3.8.9 Levels of soil fertility

Soil fertility is the status of soil with respect to its ability to supply elements essential for plant growth without a toxic concentration of any elements. Soil fertility is determined with several methods, and this information is the basis for making fertilizer commendations (Henry, 1991).

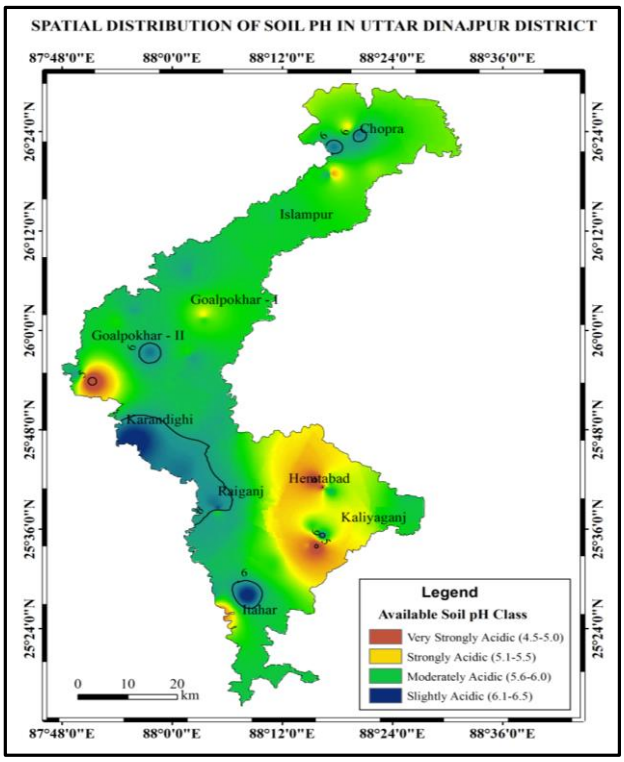



**Figure 3.19** Soil $p^H$ status in Uttar Dinajpur District.

The fertility maps have been prepared by Parker's Nutrient Index process. Followed by Parker's Nutrient Index process (Singh, et al, 2018) of one area with those of additional it is essential to obtain a single value for every nutrient. Hence, the nutrient index value (NIV) introduced by (Parker, et al, 1951) is useful and describes the fertility status of soils for the purpose of mapping. Micro and macronutrients content in soil samples of Uttar Dinajpur District is considered in table 3.31 (Appendix IIIb). The percentage of samples in each of the four classes; low, medium, high and very high is multiplied by 1, 2, 3 and 4 respectively. The summation of the figures thus obtained is divided by the total number of samples and it is computed as below:

$$\mathbf{NIV = (N_L x1 + N_M x\ 2 + N_H x\ 3.....) / (N_L + N_M + N_H .....)}$$

Where,

$N_L$ = Number of samples falling in the low category of nutrient status.

$N_M$ = Number of samples falling in the medium category of nutrient status.

$N_H$ = Number of samples falling in the high category of nutrient status.

Individual indices are considered for modified index classification of different nutrients like N, P, K, S, pH, Fe, Mn and OC. The output nutrient index values (NIV) have been classified as: < 1.67 indicates low nutrient situation, 1.67 to 2.33 is the medium situation, 2.33 to 2.99 is high situation and > 2.99 is very high situation (Ramamoorthy and Bajaj, 1969).

**Table 3.32** Rating chart of micro and macro nutrients in soils of Uttar Dinajpur District.

| **Soil quality indicators: pH** | | | | | |
|---|---|---|---|---|---|
| **Very strongly acidic** | **Strongly Acidic** | **Moderately Acidic** | **Slightly Acidic** | | **Reference** |
| 4.5 to 5.0 | 5.1 to 5.5 | 5.6 to 6.0 | 6.1 to 6.5 | | Fertility level of soil as per Indian standard (NBSS & LUP) |
| Soil quality parameters | | | | | |
| | **Low** | **Medium** | **High** | **Very High** | |
| N | <280 | 280-450 | >450 | - | |
| P | <45 | 45-90 | 90-190 | >190 | |
| K | <200 | 200-350 | >350 | - | |
| S | <10 | 10-15 | 15-50 | >50 | |
| Mn | <1.0 | 1.0-10 | 10-25 | >25 | |
| Oc (%) | <50 | 50-100 | 100-150 | >150 | |
| | **Very Low** | **Low** | **Medium** | **High** | **Very High** |
| Fe | <10 | 10-25 | 25-50 | 50-100 | >100 |

Nutrients index value (*NIV*) for different micro and macronutrients of sample soils in the study area is represented and findings in the table 3.33.

**Table 3.33** Nutrient index value of sample soils

| **Fertility elements** | **Nutrient index** | **Remarks** | **Nutrient rating** |
|---|---|---|---|
| pH | 2.64 | High (Moderately Acidic) | Less than 1.67 **Low** |
| Nitrogen | 2.14 | Medium | |
| Phosphorus | 2.08 | Medium | |

| | | | |
|---|---|---|---|
| Potassium | 2.56 | High | 1.67 to 2.33 **Medium** 2.33 to 2.99 **High** Above 2.99 **Very high** |
| Sulphur | 2.56 | High | |
| Manganese | 1.62 | Low | |
| Iron | 2.14 | Medium | |
| Organic Carbon | 3.28 | Very high | |

Source: Compiled by the researcher from table 3.32

Lastly, soil fertility is the status of a soil i.e. production of different crops and soil productivity is the result of various factors influencing soil management. The productivity of soil depends on soil fertility. Generally, good fertility of soil gives good quality produce. But each and every year soil is losing its fertility through production. So, it is important that, the study of soil fertility and productivity is to be used realistically as well as intensively.

### 3.9 Conclusion

It is observed from the above discussion that agricultural land change has been unique in improving their agricultural set-up. It has been possible due to the increase in population, transformation of agricultural land to different land (non-agricultural), technical improvements, irrigation area expansions, urban area expansion and increases of soil fertility and productivity which collectively create a forceful and progressive situation i.e. make overall agricultural progress. Out of the non-physical factors, population growth is most vital which forced the agricultural land to convert to settlement. In the district, while analyzing the overall study period the total population was 7,74,487 persons in 1961 but it has increased to 30,07,134 persons in 2011. Not only that, fragmentation of land is a major problem of the district. Because of absence of healthy and regular land reforms, the size of land holdings area is decreased and number of land ownership increased day by day. Under such conditions, in small plots, it is very difficult to apply scientific instruments practices. In the study area, cultivators are increased by 28.64 per cent over the study period (1971-2011) i.e. in 1971, it was 179,829 and it has increased to 254,491 cultivators in 2011. Urban expansion is another vital factor to change agricultural land. A total of 6.05 $km^2$ of agricultural land has been converted into urban area i.e. 35.63 $km^2$ area was under the urban area in 1971 and it has increased to 41.68 $km^2$ in 2011. Irrigation also plays a vital role in those vast non-agricultural areas which are converted to agricultural land and potentially developed but sometimes agricultural lands suffer the vagaries from the seasonal rainfall in the district. The irrigation practices in the district is present but not sufficient for the whole agricultural season. Lack of irrigation in different seasons has a negative effect on agriculture and as a result, remarkable loss to the district occurs. It is observed in the study period that total 7,466.68 hectares of agricultural land was

under irrigation in 1971 but it has seen tremendous growth to reach 151,591 hectares in 2011 (about 2,030 per cent increased). It is good sign for the district and depending on the irrigation increased net area sown and crop production and productivity has also increased. In 1993-94, total net area sown was 257.34 thousand hectares. But it has increased to 276.73 thousand hectares in 2013-14. Per hectare yield rates of rice also increased; in 1993-94 it was 1,562 kg and it has increased to 2,530 kg per hectare. Not only increased the yield rate per hectare, total crop production has also increased. Over the study period, wheat production has increased by 38.30 thousand tonnes (51 thousand tonnes was in 1993-94 and it has increased to 89.30 thousand tonnes). Lastly, 48.46 per cent cropping intensity is increased due to the availability of irrigation and spread of electrification in rural areas. Soil fertility is also another factor for changing agricultural land use. Fertility status is generally medium to high (table 3.34). Not only that, farmers also used tremendous of chemical fertilizer in crop field's which increased artificial fertility. As a result, crop production and productivity quantity has increased in the district year after year.

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