CHAPTER – 5

AGRICULTURAL INOVATION AND THEIR POTENTIALITIES

5.0 Introduction

Agricultural innovation ingredient may be considered for the regionalization of agriculture. These ingredients may be categorised into two broad categories, viz. inputs and outputs. Input elements are those indicators that are required for crop production. These are the intensity of irrigation, HYV seeds, chemicalization, mechanization, and crop productivity etc. (Halder and Das, 2010). The first three are the major indicators of increasing agricultural production. These three are called the trio of basic inputs which may be considered as push factors of agricultural developments. The intensity of mechanization and crop productivity are the output ingredients and these are considered as independent variables. Crop productivity has been considered to delineate the level of agricultural development.

5.0.1 Different inputs variable for agricultural development

i. Irrigation

Irrigation is one of the best essential input ingredients in Uttar Dinajpur District because rainfall is uncertain, unreliable and erratic in nature. In the district, only one-third of the total cropped area is under different types of irrigation. It helps grow agricultural crops, maintain landscapes, re-vegetate disturbed soils in dry areas and during periods of less than average rainfall.

ii. HYV seeds

The use of HYV seeds in the agricultural field is considered to be the basic input ingredient for conquering higher productivity. According to Khullar (2008) "The yielding variety of seeds are most important input of agricultural production under the green revolution technology. Their chief characteristic is improved responsiveness to viscose fertilizers, which helps twofold cropping. The high yielding variety (HYV) seeds were perhaps the particular most essential input in the Indian Green Revolution (IGR)".

iii. Chemicalization

Chemicalization means trends of chemical fertilizers and pesticides used for better productivity in the agricultural sector. It is the third important input ingredient, which is rapidly used for increasing yield rate. It has been noticed that about 60 per cent growth in agricultural production can be achieved by applying chemical fertilizers in the district (PAO, Uttar Dinajpur).

5.0.2 Different outputs variable for agricultural development

iv. Mechanization

Mechanization means the use of improved machinery for agriculture practices like the density of threshers, tractors etc. Mechanised agriculture is the process of using agricultural machinery to mechanise the work of agricultural. In modern times, agricultural developments depend on the mechanization because it makes agricultural fields in short time and powered machinery has replaced many farm jobs formerly carried out by manual labour.

v. Crop productivity

Crop productivity is measured as the ratio of agricultural outputs to agricultural inputs. Aside from providing more food, increasing the productivity of farms affects the region's prospects for growth and competitiveness of the agricultural market, income distribution and savings and labour migration. The level of agricultural productivity means the amount to which the economic, cultural, technical and organizational as well as governmental variables are capable to exploit the abiotic properties of the area for agronomic production (Singh, 1979).

5.1 Traditional method of agriculture

Agriculture is the primary occupation of a large part of the working population of Uttar Dinajpur District. Traditional farming is done according to the ancient crop production system and the original type of agriculture as it has been practiced for thousands of years in the district. Traditional farming is very similar to organic farming where the farmer has a mixed farm of livestock, fruits and crops. Uttar Dinajpur District is a really agriculturally back-ward district of West Bengal, because there are many systems in ordinary use which are for more complicated. For instance, there may be rows of the crop, side by side, as noticed during the field study. The farmers interested to traditional method, because improper drying of seeds reduced their viability to the extent that they might lose their ability to germinate, traditional systems of cultivation practices are well adapted to the environmental condition and traditional knowledge of indigenous communities growing cereals and other agricultural crops have enabled them to maintain an ecological balance. Lastly, the land plots are small of the farmers. They can easily plough with bullocks but the tractor and harvester cannot move on the small plots easily. So, they are interested in the traditional method used in their agriculture fields. The percentage of the traditional and modern method of agriculture in Uttar Dinajpur District is presented in table 5.1.

Table 5.1 Method used in the agricultural sector of Uttar Dinajpur District.

Sl. No.	Methods use	No. of households	% of the households
1	Traditional	154	42.78
2	Modern	112	31.11
3	Both (Traditional+Modern)	94	26.11
Uttar Dinajpur	**All methods**	**360**	**100.00**

Source: Based on the households survey of 360 respondents.

Table 5.1 shows the use of methods of the agricultural system at farming practiced in Uttar Dinajpur District. Most of the farmers use (42.7 per cent) the traditional method of agricultural instruments and only 31.11 per cent of the total farmers in the study area used modern method of agricultural instruments in their agricultural sector. 26.11 per cent of the total farmers have used both the methods (Traditional and Modern) in the district. So, it is clear from the above table that, most of the farmers are not introducing the modern system of agricultural instrument, and mostly use the traditional method in their agricultural sector in the district. Because their per capita income is low and they cannot afford to take advantages of modern technology.

5.2 Mechanization in agriculture

Mechanization stands for modernization. The traditional method of farming is not compatible with the modern farming system. That is why sufficient farm machinery is required to utilize these factors to get higher productivity. In the study area, farmers are still practice traditional farming mainly for unavailable modern agricultural inputs. But in recent times (2005-06), farmers are aware of improving productivity because of which they use modern instruments in the agricultural field. In the traditional method, farmers use ordinarily local wooden plough, harrow, weeding hook, sickle basket etc. in agriculture. The plough and harrows are pulled by the bullocks for preparing the field along with plough. A weeding process on water logged paddy lands is performed especially by female labour. For this purpose of lifting water from wetlands and wells, high level of *Baskets* or K*urni* with wooden *Latha* and rope are used. And the purpose of transportation of agricultural crops and goods, bullock driven wooden carts are used in the study area.

The process of modernization involves identifying the proper subject matter areas and portentous appropriate technology interference. In the method of development, we should not lose sight of the different concerns confronting the agricultural sector, which dominance the modernization procedure. The concerns are globalization, irrigated vs. rain fed agriculture, size of farm holdings, etc. Further, the concept of modernization to make the farmers and others concerned, the expansion system needs to be revamped with the farmer oriented approaches,

continuing privatisation of the service and use of the cyber extension. The hypothesis of modernization of Uttar Dinajpur is depicting in figure 5.1.

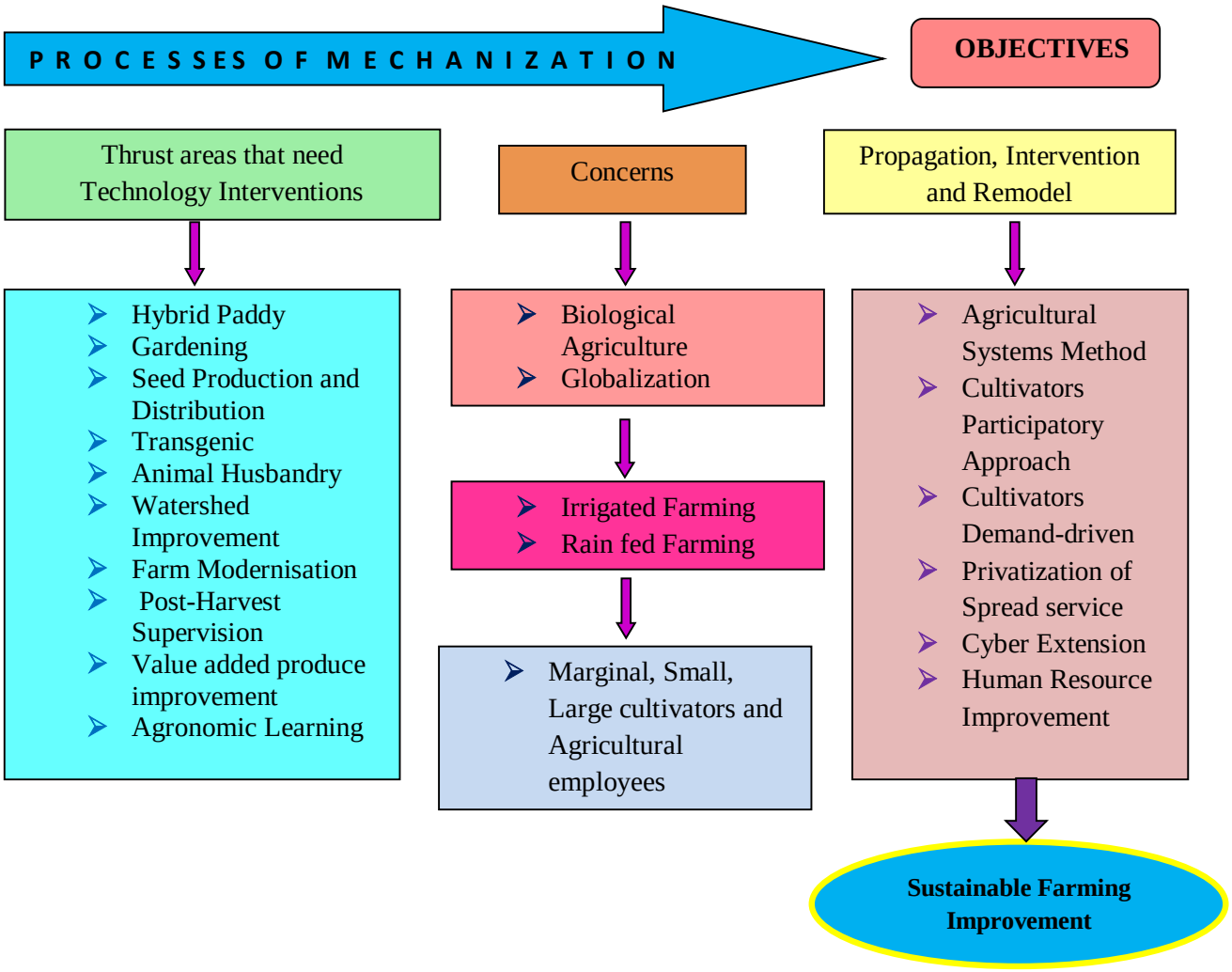


Figure 5.1 Paradigm for modernization of Uttar Dinajpur agriculture.

Source: Kannaiyan, 2001

But now-a-days farmers can do easily the mechanization in the agricultural field and some changes in farm implements have occurred. They use the iron plough, iron-weeding wheels, electric, diesel and kerosene pump set for irrigation in this district. Recently for mechanization of agricultural goods government has supplied tractor, harvesters to the cultivators on either loan basis or subsidy. The use of tractors ploughing land is increasing day by day in all blocks of the district. The traditional indigenous farm has lack of efficiency but modern tools have brought efficiency in the agricultural sector. But fragmentation into small landholders may make mechanization inefficient, particularly the use of tractors and harvesters, because of the form and dimensions of the land. In Uttar Dinajpur District, mechanization in farming has been reduced because of the subdivision of agricultural fields; while farmers are using increasingly human and animal power. Most of the marginal and small farmers of the district used their own

labour and animal power when they cultivate, seeding and cutting the crops. When I interviewed the 360 farmers, 42 per cent of them answered that, “mechanization is reduced because of the small size of lands,” 36 per cent said that “mechanization is reduced because the cost is rising every day,” 22 per cent suggested changing the structure of mechanization to favour smaller implements, enlarging the properties and removing the hedges. It is difficult to use tractors because land areas are very small and tractors are not easily manoeuvrable.

Modern farming tools and technology like tractors, harvesters, threshers and sprayers are also imperative for the successful cultivation of different HYV crops. These varieties, as stated at the outset, require elaborate arrangements of canal and tube well irrigation. Raising of the three or four crops from the same field within one year is possible only if modern technology and HYVs is available to the farmers. The traditional plough and bullock-carts are less efficient to finish the agricultural operations on time. Enormous machinery, like tractors, harvesters, sprayers, tillers and pumping sets, etc. are required for the timely operations of sowing, weeding, spraying and harvesting of crops. Not only that, mechanization of agriculture also helps in the judicious utilization of complementary inputs like irrigation water supply, chemical fertilizers, insecticides and pesticides. A farmer, having a tractor and blade terrace, manages to grade his field to a much better level in the course of time as compared to a farmer not having the similar sources of power and equipment at his disposal. Moreover, the proper grading and levelling of fields help in reducing water losses and economize on the labour required for irrigation.

Table 5.2 Mechanical method used in the agricultural sector in Uttar Dinajpur District.

Use Mechanization method	No. of households	% of the households
Yes	189	52.50
No	171	47.50
Total	**360**	**100.00**

Source: Based on households survey of 360 respondents.

An examination of table 5.2 reveals that about 52.50 per cent of total farmers use mechanical technology in the district. They are using agricultural field tractors for the plough, harvesters for cutting the crops, sprayers for the spread of pesticides, pump set and sub-marshible pump for good and adequate irrigation in marginal and small operational landholdings in the study area. But the rest (47.50 per cent) of total farmers use non-mechanical as well as traditional power.

5.2.1 Changing indicators of traditional to modern method in agriculture in Uttar Dinajpur District

Many countries have been ahead of others in realizing the meaning of mechanization in agricultural sectors. No land can be properly irrigated unless water can be raised by electrically driven centrifugal pumps or diesel pump sets. No pesticides can be applied to the spray in agricultural fields except by means of mechanically operated sprayers. Soil moisture can't be conserved except when the soil is ploughed deeply with the help of iron-made soil scratchers. Thus, it can be seen that a farmer has to create the use of iron-made apparatus and machines in one form for boosting his agricultural production. Nevertheless, many farmers go on to use age-old agriculture implements.

As such, a reform in the system of land-use privileges and viable units of operation must be undertaken before considering mechanization. Traditional habits acquired by previous creation of farmers tend to survive although the general character of the rural landscape may have improved significantly (Singh, 1976). Finally, by changing the altitude of the conventional farmers towards the adoption of modern input and technique, the process of modernization in agriculture can be accelerated. At present, agriculture in Uttar Dinajpur District is well-matched to modernization, and agricultural farmers are already reacting in an economically logical way to their environment.

Table 5.3 Indicators of traditional to modern agricultural systems in Uttar Dinajpur District.

Sl. No.	INDICATORS	
	Traditional	**Modern**
1.	Protected economy	Marketplace economy
2.	Import based oriented	Export based oriented
3.	Exploitative Farming	Sustainable Farming
4.	Monoculture and crop concentration	Farm Modification
5.	Use of Inorganic composts and chemical insecticides	Use of Bio-fertilizers, Bio-pesticides and Bio control in agriculture
6.	Mostly male-Dominated	Mostly women's empowerment and emancipation
7.	Individualistic and unorganized	This system organized into self-help groups and user groups
8.	Ignorance of post-harvest handling and value adding.	Value addition
9.	Generally non-market oriented	This system is based on commercialization and agribusiness.
10.	Normal choice and propagation through seed.	Biotechnology and Transgenic for yield development.
11.	Old system like; Radio and print regime.	Advanced system like; Computer and Computer regime.

Source: Kannaiyan, 2001

But in recent time awareness levels or mechanization methods have increased among the district's farmers because follow up the some important step taken by the local administration. These are;

1. Regular basis discussion of the advantages of modernization with the farmers for the use of new technology in their agricultural practice.
2. Supply of HYVs to the farmers for increasing their crop production (PAO, Uttar Dinajpur).
3. To increase information and awareness between the farmers to increase the production and productivity of various crops.
4. Due to the training programmes conducted by KVK on improved technologies related to the agriculture and allied fields benefited the cultivators in terms of increased crop production and improved farm income.
5. The Kisan Call Centre (KCC) scheme is also implemented across the district for the new technology benefits of farmers (Office of the Deputy Directorate of Agriculture, 2017).

5.2.3 Level of modernization in agriculture

Agriculture mechanization means the use of modern mechanical devices for different agricultural practices. It increases agricultural productivity and avoids human drudgery. Mechanization of agriculture implies the use of tractors, harvesters, use of HYV seeds and many other farm operations. The apparatus of these technologies as indicators are, consequently, to be used for the measurement of the actual levels of agricultural modernization. Actually, agricultural modernization started in the district in early 1980 (PAO, Uttar Dinajpur), when the new agricultural instruments are available in the local market. The variation in natural, socio-economic and cultural in Uttar Dinajpur District exercise a critical and differential impact on the adoption of modern farm technology at individual farm level. It is right that the inequalities in the gains in individual farming due to imbalanced modernization have made the rich richer and poor poorer. Not only that, but the inequalities also depended on the degree of modernization which has generated social and political problems.

For the actual degree of modernization in agriculture, the data on diagnostic techno-chemical indicators of modern farm technology in the block was processed, tabulated and related to the corresponding district level values and the location quotients obtained. For this purpose, five farm implements factors for mechanization are considered. These are tractors per 1,000 hectares of cultivated area, irrigation pump sets per 1,000 hectares, the area under High Yielding Varieties as a percentage to the total cropped area, use of chemical fertilizers in

kilograms per hectares of cropped area and thresher implements per 1,000 hectares. The five location quotients thus derived were summed up to arrive at the composite index level value of modernization in agriculture (Singh & Dhillon, 2005). The equation may be written as-

$$CI_{mo} = \frac{Trb}{Trd} + \frac{Ipsb}{Ipsd} + \frac{Hyvb}{Hyvd} + \frac{Chfb}{Chfd} + \frac{Hib}{Hid}$$

Degree of modernization in agriculture = ΣLQs/n x100

Where, CI_{mo} = the composite index level of modernization in agriculture.

Tr = tractors per 1,000 hectares of cultivated area.

Ips = irrigation pump set used per 1,000 hectares of cultivated area.

Hyv = the area under HYVs as a percentage of the total cropper area.

Chf = use of chemical fertilizers in kg per hectare of the cropped area.

Hi = harvester used per hectare of the cropped area.

n = the number of factors of modern farm technology used in the district.

b and d indicate the symbolize subscripts the enumeration unit (block) and the whole region (district).

From the above mentioned factors used for the modernization in agriculture of the district and their situation are presented in the table 5.4.

Table 5.4 Actual nos. of each modernization elements in Uttar Dinajpur District.

Name of the C.D. Blocks	Tractor per 1,000 ha	Irrigation pump sets per 1,000 ha	HYV seeds area in (%)*	Chemical fertilizer (NPK) per ha **	Harvester used per 1,000 ha
Chopra	3	61	83.95	128	2
Islampur	5	86	80.71	143	5
Goalpokher-I	2	81	93.95	176	2
Goalpokher-II	3	119	93.65	187	4
Karandighi	5	126	96.63	255	6
Raiganj	9	175	90.97	263	7
Hemtabad	6	170	92.44	173	4
Kaliyaganj	3	219	95.72	203	3
Itahar	5	210	87.25	195	6
Uttar Dinajpur	**4**	**138**	**91.24**	**191**	**4**

Source: i. Office of the Deputy Director of Agriculture, Karnojora, Raiganj, Uttar Dinajpur
ii. * Office of the Bureau and Applied Economics & Statistics, Government of West Bengal, Karnojora, Raiganj, Uttar Dinajpur
iii. ** Block Development Office, Different Blocks, Uttar Dinajpur District.

Composite Index level of modernization in agriculture for Karandighi Block discuss as under

$$\mathbf{CI_{mo}} = \frac{5}{4} + \frac{126}{138} + \frac{69.63}{91.24} + \frac{263}{191} + \frac{7}{4}$$

1.25 + 0.91 + 1.05 + 1.37 + 1.75 = 6.33

Degree of modernization in agriculture = $\frac{6.33}{5} \times 100$

= 126.60 per cent.

The final percentage values of different blocks giving the proper value of localization of agricultural modernization are given below. Hence, the percentage values (126.60 per cent) indicate the level of modernization in agriculture for the Block Karandighi. In the same process all modernization values for all blocks were calculated and represented in the table 5.5.

Table 5.5 Composite index value in different blocks in Uttar Dinajpur District.

Name of the C.D. Blocks	Composite Index Value of Modernization (%)
Chopra	65.65
Islampur	94.80
Goalpokher-I	70.80
Goalpokher-II	92.20
Karandighi	152.60
Raiganj	126.60
Hemtabad	112.80
Kaliyaganj	103.80
Itahar	120.00
Uttar Dinajpur	**100.00**

Source: Research's calculation compiled from table 5.5

From the table 5.5, it is revealed that majority of the blocks (five blocks) namely Karandighi, Raiganj, Hemtabad, Kaliyaganj and Itahar have been identified as above the district level modernization (100 per cent), and rest four blocks namely Chopra, Islampur, Goalpokher-I and Goalpokher-II are below it. The expected block patterns appear in figure 5.2 and show the block to block variations in the availability of irrigation facility, size of operational holdings, farmer's education, infrastructural facility and many others. The pattern in the degree of modernization in agriculture and depictions of dissimilarity in the distribution has been classified into three broad categories. Modernization value less than 95 per cent indicate the low modernization in agriculture, 95-125 per cent indicates the medium modernization in agriculture and percentage value above 125 per cent indicates the high modernization in agriculture in the block and spread the new technologies with in the blocks.

Table 5.6 Agriculture modernization zone of Uttar Dinajpur District.

Index value (%)	No. of C.D. Blocks	Name of the C.D. Blocks
<95	4	Chopra, Islampur, Goalpokher-I and Goalpokher-II
95-125	3	Hemtabad, Kaliyaganj and Itahar
>125	2	Karandighi and Raiganj

Source: Compiled by the researcher based on table 5.5

The distribution of low level of modernization in agriculture is observed in four blocks namely Chopra, Islampur, Goalpokher-I and Goalpokher-II. This zone is located in the Northern part of the district. Low modernization in agriculture corresponds directly to the

district patterns of not suitable crop areas, comparatively low irrigation facilities, modern technology easily not adopted, lack of credit system in agriculture and low per capita income of the farmers which is the main barrier for the use of new technology in agriculture.

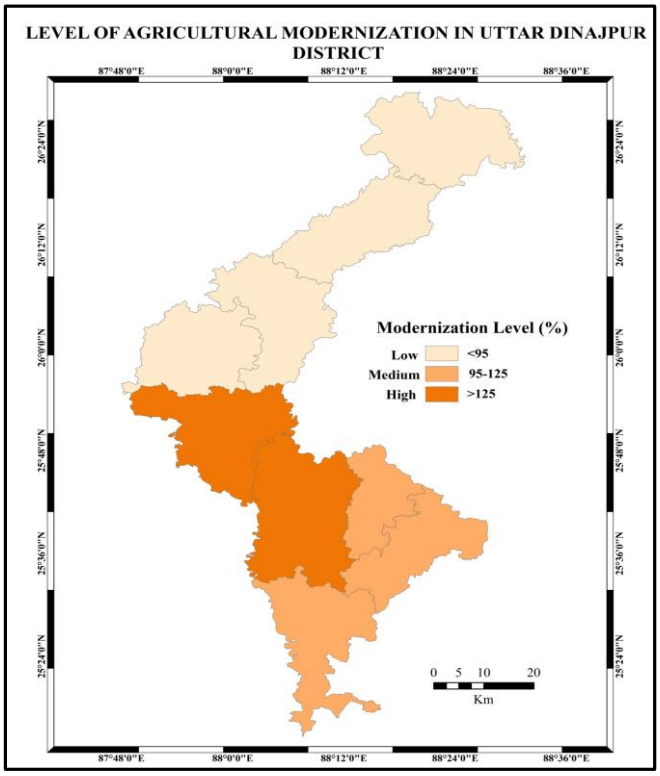
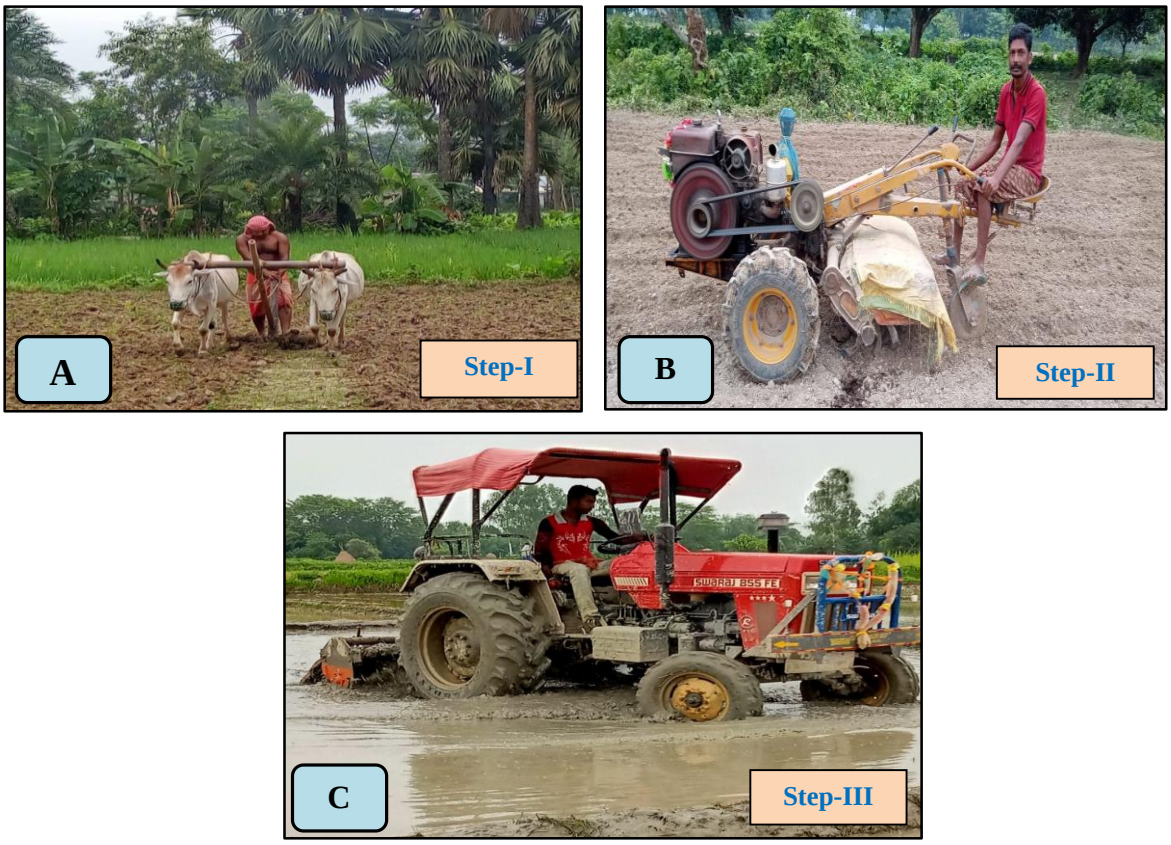


Figure 5.2 Level of agricultural modernization in Uttar Dinajpur District.

These blocks' positions are far below the district average (100 per cent) of modernization. Medium modernization in agriculture is observed in three blocks namely Hemtabad (112.80 per cent), Kaliyaganj (103.80 per cent) and Itahar (120.00 per cent) with the modernization index 95-125. Medium modernization in agriculture in these blocks corresponds closely to the small size of landholdings; irrigation intensity is below 50 per cent and low per capita income of the farmer's households which is the main barrier shift from the traditional farm operations towards modernization in agriculture. This zone is located in the southern part of the district. The high distribution of modernization in agriculture is observed in two blocks namely Karandighi (126.60 per cent) and Raiganj (152.60 per cent). This zone lies in the central part of the district (figure 5.2). In these two blocks an integrated distribution of modern farm technology suggests that the spatial pattern of modernization levels are closely related to high irrigation intensity (more than 60 per cent irrigation intensity), big size of operational holdings (majority of farm size above five hectares), use of improved mechanical and biochemical techniques and high educational level of farm workers etc.



A) Land ploughing by bullock in Goalpokher-I block (traditional method) B) Land ploughing by power thriller in Kaliaganj block (modern method) C) Land ploughing by tractor in Raiganj block (modern method).

Plate 5.1 Mechanization in agricultural sector.

5.2.4 Effects of Modernization in agricultural sector

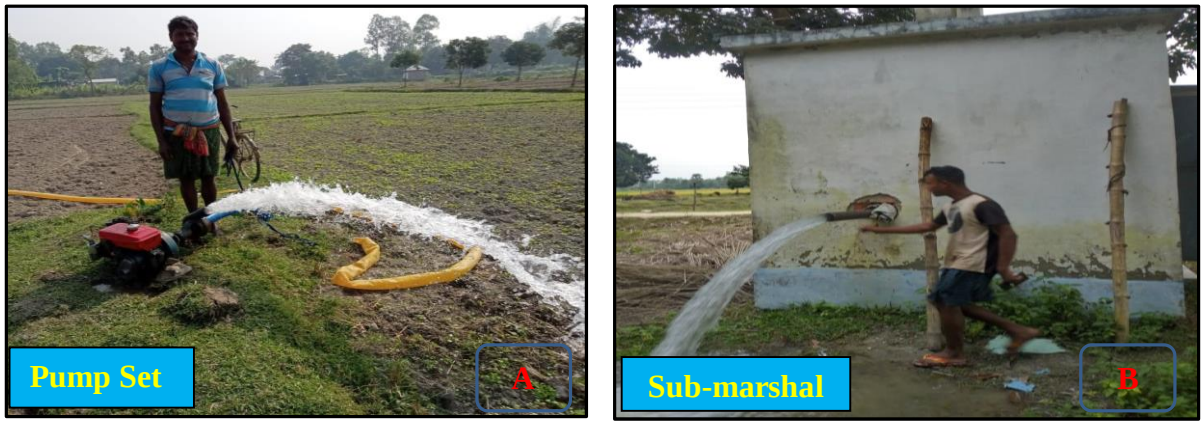
The modernization in agricultural sector helps to improved input materials. As a result, mechanical technology used increase day-to-day. Before 15-20 years ago (2001-02) cultivators depend mainly of plough and sometimes power triller for tillage the agricultural land but in recent time (2015-16) cultivators are using tractors. In irrigation sectors cultivators are using deep tube well and sub-marshals pump and for crop threshing they are easily using harvesters and threshers. Not only that, for modernization in agricultural sector huge amount of chemical fertilizers and pesticides used. Therefore, yield rate of most crops has increased (already discussed in chapter-3).

However, agricultural debt and poverty make the use of basic and modern inputs hard to achieve. Not only that, sometimes modernization success will prove difficult due to the non-availability of rainfall, low irrigation facility, the small size of landholdings, agricultural loaning facility too difficult and many others. On the other hand, there are a number of negative

factors that usually hamper the use of modern inputs. These are the structural conditions such as the system of land tenure; the traditional labour input pattern, the low educational level of farm workers, the poor maintenance service and difficult agricultural credit (Dhillon, et al, 2005).

A) Paddy threshing by labour force (traditional method) B) Paddy threshing by manual machine C) Paddy threshing by tractor D) Paddy threshing by harvester (modern method).

Plate 5.2 Mechanization in crop harvests.



A) Irrigation water supply by pump set B) Irrigation water supply by sub-mershal.

Plate 5.3 Mechanization in irrigation system.

5.3 Use of HYV seed in agriculture

The issue of usage of HYV seeds, modern implements and its impacts on production/ productivity per hectare. These types of seeds are very fundamental input for introducing the new technology to crop production, propagation and multiplication. Introduction of High Yielding Varieties seeds (HYVs) is one of the important steps initiated for agricultural development in Uttar Dinajpur District. The farmers use HYVs seeds mainly short duration paddy has been introduced in the district since 1973-74 and wheat *'Sonalika', PBW-343* varieties have been introduced in 1981-82 and maize *HQPM1* and *HQPM5* varieties have been introduced in 1995-96 (Office of the Deputy Directorate of Agriculture, Uttar Dinajpur). The amazing results of high yield variety in the other district and cultivators of this district finally convinced to adopt this new method. District seed farms are intended to multiply rapidly seeds of improved strains in order to make each block self-sufficient in the supply of HYV seeds. There is no doubt that most of the farmers in the district use more amount of HYV seeds in their farms. Because HYVs have certain advantages over the traditional varieties of crops which may be highlighted as under-

a. HYVs have a shorter lifecycle and thereby enable the farmers to go for multiple cropping. For example, new seeds of paddy and wheat complete their lifecycle in 105-115 days respectively. On the other hand, the traditional varieties of paddy and wheat take about 125-145 days respectively to harvest (farmer's personal interview).
b. HYV needs less water for superior yields. The yield per unit area is low. If it is measured in terms of water required per quintal of wheat or paddy, the new seeds have need of less water as compared to that of the traditional varieties. HYVs thus economize on water also as the crop remains in the field for a shorter stage.
c. HYVs under optimal conditions require more labour per unit area and thus help in generating more employment. Previous to the introduction of HYVs, the farmers over parts of the district, particularly in the rainfed areas were exclusively dependent on the arrival of monsoon for the start of their agricultural performance. They used to remain unemployed through the months of the summer period after the harvest of *Rabi* crops. But now, the farmers and the dependent labourers get work in different agricultural operations throughout the year.
d. HYVs is scaled impartial which means that other things being remaining equal, the large farmers and the tiny farmers are likely to get the production and profit in the same section. In other words, the new seeds are not biased towards the large or the tiny farmers.

e. The adoption of HYVs does not require any special skill and farmers of various socio-economic and cultural backgrounds can adopt the new seeds easily. A minor adjustment in the sowing dates of wheat or paddy is required as HYVs need relatively cool temperatures at the time of sowing. For example, in the district, the time of wheat prior to the Green Revolution were in the third or last week of October when the day temperature used to be around 34ºC, but now wheat is generally sown in the district not before the last week of November when the day temperature reads about 30º C and the night temperature falls around 17ºC. The farmers have, however, very well adjusted their sowing and harvesting dates on the basis of their experience during the last twenty-five years. In this regards the actual proportions of HYVs paddy area and total paddy area in Uttar Dinajpur District during 2015-16 are represented in the table 5.7.

Table 5.7 Block-wise total paddy area and HYVs paddy area in Uttar Dinajpur District.
(Area in hectare)

Name of the C.D. Blocks	No. of survey Households	Total paddy area	HYV paddy area	% of HYV to total paddy area
Chopra	360 Households	18.75	14.45	77.06
Islampur		27.18	15.35	56.47
Goalpokher-I		13.85	09.48	68.44
Goalpokher-II		14.56	10.38	71.29
Karandighi		20.56	13.85	67.36
Raiganj		19.83	15.60	78.66
Hemtabad		23.20	14.92	64.31
Kaliyaganj		21.35	14.68	68.75
Itahar		15.95	11.95	74.92
Uttar Dinajpur		**175.23**	**120.66**	**68.85**

Source: Based on a household survey of 360 respondents.

From the table 5.7, it is clear that the HYV paddy area in Uttar Dinajpur District is 68.85 per cent of the total area under paddy cultivation on the basis of household's survey in different blocks of the district. The block Raiganj recorded the highest proportion of area under HYV paddy that is 78.66 per cent of the total paddy area is devoted to HYV crops. And followed by the Chopra, Goalpokher-II, Itahar and Hemtabad Blocks with 77.06 per cent, 71.29 per cent, 74.92 per cent and 68.75 per cent are of HYV paddy area respectively. It is observed during the time of field survey these block's farmers used HYV seed of paddy namely *Ranjit, Jaya, Biplav, Pankaj and Masuri*, etc. The remaining four blocks namely; Islampur, Goalpokher-I, Karandighi and Kaliaganj Block adoption of HYV paddy by the cultivators are found to be low. It is a fact that the non-availability of HYV seed supply, irrigation problem is found in these blocks. The farmers of these block are more interested in the cultivation of traditional varieties of crops especially produce of cash crops like; jute, oil seeds, and turmeric, etc. But day-to-day farmers are growing their interest in HYVs crop production. Area covered by

different crops in different years of Uttar Dinajpur District is presented in the table 5.8 (Appendix V).

It can be observed from the table 5.8 that, the total area brought under HYV paddy in 1995-96 was 49.06 thousand hectares and within 20 years total area of HYV paddy area which has increased about four times i.e. 181.10 thousand hectares in the year of 2015-16 in the district. The area of HYV wheat has also increased. HYV wheat area in 1995-96 was 17.05 thousand hectares which increased to 53.33 thousand hectares in 2015-16. HYV jute area in 1995-96 it was 5.25 thousand hectares and it is increased to 26.72 thousand hectares in 2015-16. It is because of the high amount use of chemical fertilizers per hectare crop area, availability of HYV seed supply from the Government offices and local markets, expansion of irrigation area by agri-irrigation department of the district. Available pesticides use in HYV crop area for the control of unwanted plants and kills the deleterious insecticides i.e. available in the local markets. Only the HYV pulses area has decreased. HYV pluses area in 1995-96 was 6.78 thousand hectares which decreased to 6.37 thousand hectares in the district. Because HYV pulses are not profitable crops today and farmers are failure interest to the sapling pluses day-by-day.

5.3.1 Use of seeds

Bradford and Cohn (1998) stated that the "Seeds area the connection between the past and the future. They contain the accumulated inherited materials of the past and the potential for its continuation in the future". The seed has been a significant development in the reproduction and achievement of gymnosperm and angiosperm plants. The primary purpose of seeds is reproduction in which plants perpetuate themselves, mainly sexually. The seed is widely in the deliberate production of seeding, known as plant propagation. In the district farmers are really backward. They are not updated in their agricultural practices. The farmers are generally three types of seed uses, like; local, hybrid and vendors. To understand the use of seeds of these parameters the farmers were categorized and findings are represented in the table 5.9.

Table 5.9 Block-wise percentage of different type seeds use in Uttar Dinajpur District.

Name of the C.D. Blocks	Local seed	Hybrid seed	Vendor seed	Percentage share
Chopra	36.84	42.10	21.05	8.15
Islampur	44.45	48.14	7.41	11.58
Goalpokher-I	59.37	28.12	12.51	13.73
Goalpokher-II	44.45	38.89	16.67	7.72
Karandighi	27.27	54.54	18.19	9.44
Raiganj	37.93	41.38	27.59	12.44
Hemtabad	51.61	51.16	3.23	13.30

Kaliyaganj	46.15	34.61	19.24	11.15
Itahar	34.48	48.27	17.25	12.44
Uttar Dinajpur	**44.20**	**41.20**	**14.60**	**100.00**

Source: Based on a household survey of 233 respondents.

The use of different types of HYV seed is measured in the household's survey based on the respondent to the author's query. From the above table, it is found that the use of local seeds is comparatively high in Goalpokher-I Block, is about 59.37 per cent and poor in Karandighi Block (27.27 per cent). Farmers are comparatively used (54.54 per cent) of HYV hybrid seeds in Karandighi Block and mostly low (28.12 per cent) in Goalpokher-I Block in the district. The highest percentages (Raiganj 27.59 per cent) of the farmers are used of vendor's HYV seeds and 3.23 per cent (lowest) of the total farmers are used of vendor's HYV seeds in Hemtabad Block. From the overall study of the district, only 41.20 per cent farmers have used HYV hybrid seeds and more than 44.00 per cent of the total farmers have used HYV local seeds in the district (table 5.11). It because non-availability of HYV seeds at the time of cropping season and farmers are not trained properly. Not only that, but low per capita income is also the most effective factor in the district's farmers. But some minor per cent of farmers uses (14.60 per cent) vendors HYV seeds in the district. The factors can be identified as seeds outlay position in the district farmers.

5.3.2 Seed outlet facilities

The availability of seeds outlet facilities improves yield by prompting early emergence, vigorous growth and highest quality output in agricultural sectors. In this parameter contrast to the household's survey data shown in the table 5.10.

Table 5.10 Block-wise percentage of seed outlets in Uttar Dinajpur District.

Name of the C.D. Blocks	**Percentage of households to the total**			
	Own	**Open market**	**Certified**	**Total**
Chopra	47.37	36.84	15.78	8.15
Islampur	55.55	25.92	18.52	11.58
Goalpokher-I	62.50	25.00	12.50	13.73
Goalpokher-II	38.89	50.00	11.11	7.72
Karandighi	45.45	22.73	31.82	9.44
Raiganj	51.72	34.48	13.80	12.44
Hemtabad	38.71	35.48	25.81	13.30
Kaliyaganj	38.46	26.92	34.62	11.15
Itahar	44.83	34.48	20.69	12.44
Uttar Dinajpur	**47.64**	**31.76**	**20.60**	**100.00**

Source: Based on a household survey of 233 respondents.

On the basis of these parameters, it is clear from table 5.10 that 47.64 per cent of the total farmers use their own HYV seeds in the different crop season. It is because most of the farmers

are less interested in the certified and vendors seed and during the crop seeding time the certified seeds are not available in the local market. They believe that the certified and open market seeds are not saved hybrid seeds to plant next year are that the seeds won't "bread true". On the other hand, there are 31.76 per cent and 20.60 per cent of the total farmers use open market seeds and certified seeds respectively. Farmers do not save seeds to plant so that they may not plant the same hybrid again. Purchasing seeds every year means that farmers can choose a different crop season. So, they purchase seeds that have been treated. Own seeds are pre-treated with a fungicide and purchasing new seed every year gives a farmer a lot more flexibility. The block-wise seed outlet of HYV seeds uses are average in Chopra block. The farmers are used own seeds is higher (62.50 per cent) in Goalpokher-I Block and lowest (38.46 per cent) in Kaliyaganj Block in the district. On the other hand, more than 34.00 per cent of total farmers used certified vendor seeds in Hemtabad Block and lowest (11.11 per cent) in Goalpokher-II Block. The number of storages and their density in different blocks of Uttar Dinajpur District shows in the table 5.11.

Table 5.11 Block-wise seed storage facility in Uttar Dinajpur District.
(Seed storage/ 10,000 ha)

Name of the C.D. Block	Number of seed storage	The density of seed storage
Chopra	09	2.43
Islampur	10	3.12
Goalpokher-I	05	1.47
Goalpokher-II	06	2.06
Karandighi	09	2.43
Raiganj	49	10.65
Hemtabad	15	7.89
Kaliyaganj	03	1.00
Itahar	08	2.22
Uttar Dinajpur	**114**	**3.75**

Source: Directorate of agriculture marketing, Raiganj, Uttar Dinajpur.

The table 5.11 shows the problems of seeds storage appearance in Kaliaganj Block. In this block, total three seed storages during the year 2015-16 and it is the lowest number in the district. The maximum number of farmers can't use seed storage's seed for the next cropping time. On the other hand, 49 seed storage is found in Raiganj Block and it is the highest in the district. Seed storage density in Raiganj Block is 10.65 and in Hemtabad Block is 7.89 per 10 thousand hectares and it is far from the district average density i.e. 3.75 per 10 thousand areas. This means that farmers are using their seeds for the next crop season easily. Remaining six blocks namely, Chopra 2.43, Islampur 3.12, Goalpokher-I 1.47, Goalpokher-II 2.06, Karandighi 2.43 and Itahar 2.22 have the seed storage density per 10 thousand areas in the district and it is far below the district's average. Non-availability of seed storage is the major

problem in each block of the district. Lack of Government help is worse in this condition. Because farmers are less interested in using HYV seeds in different crop seasons.

5.4 Introduction of chemical fertilizers

For very basic and general terms, chemical fertilizer is a compound (Collection of ingredients) that has been chemically processed or refined to increase the potency of soil for normal plant growth. In the study area, farmers are the introduction of chemical fertilizer in the mid of 19th century (PAO, Uttar Dinajpur). In the early stage, agriculture has been practiced with wild seeds in shifting. But the last 15-20 years have witnessed some remarkable changes in use of chemical fertilizer in agriculture. Though, after irrigation, chemical fertilizer is the second most important input required for the successful cultivation of HYV. The recommended dose of chemical fertilizer for new seeds of paddy and wheat in terms of NPK in 90:45:45 kg per hectare i.e. 180 kg per hectare. But it is noticeable that the national average of NPK consumption is about 80 kg per hectare while in Punjab and Haryana the average consumption of chemical fertilizers used in per hectare is about 243 kg and 220 kg respectively (https://geographyandyou.com). With the passage of time, population and requirement of food have increased and sedentary subsistence agriculture has converted to the commercialization of crops to gain more profit in the agricultural sector. Before the 1960s, farmers depended almost entirely on their fertilizers or animal manures. The response of traditional varieties to chemical fertilizers is more in terms of vigorous vegetative growth which leads to pre-harvest lodging of the crop. The lodging of crops reduces the yield per unit area. But modernization in agricultural sectors, as well as industry with improvements in the manufacture of the commercial fertilizer industry has revolutionized more chemical fertilizing practices in agriculture.

There are two types of fertilizers that are mainly used in Uttar Dinajpur District namely-

i. Chemical fertilizer and

ii. Bio-fertilizer as well as organic fertilizers.

Chemical fertilizer used is most important for increasing crop production per hectare. About 61 per cent of additional crop production is in the post green revolution period in the district. After the introduction of chemical fertilizers in the last few decades, farmers were happy to get increased yield in their agricultural field from the beginning. But now-a-days fertilizers started displaying ill-effects such as leaching out, polluting water, destroying micro-organisms, reducing the soil fertility and thus causing irreparable damage to the overall system in their

cropped areas. It is observed from the household survey farmers of the district normally used two types of fertilizers which is shown in the table 5.12.

Table 5.12 Types of fertilizer used by the district farmers.

TYPES OF FERTILIZERS	
Organic Fertilizers	**Inorganic (Chemical) Fertilizers**
These types of fertilizers are derived organically from animals (especially cow and buffalo) or vegetable matters. Naturally, occurring organic composts include manure, slurry, worm casting, peat, seaweed and humic acid, etc.	These types of fertilizers are man-made formulations that can be formulated for different speeds of release. These are derived from adding altered chemicals like; Nitrogen (N_2), Phosphorus (P_2o_5), Potassium (K_2o), etc.

Source: Researcher's field observation.

After 1960-61, the scientific management of farming, traditional methods replenishing soil fertility have been replaced by the huge use of chemical fertilizer. More increasing population pressure in the district and its primary terminator demands on food additive crops. In this situation, the apparition of the green revolution, the use of chemical fertilizer has been increasing very vastly in each block of the study area. The rate of chemical fertilizers per hectare of the cropped area increased from only 23.82 kg in 1990-91 to 75.31 kg in 2000-01 to 112.50 kg in 2010-11 and to 139.68 kg in 2015-16 in the district. Still, the district is far behind the state average of 169 kg per ha in 2010-11 (Record as per District Statistical Hand Book). In the district' farmers are randomly using chemical fertilizers from the mid of eighty in their agricultural sector. But many other farmers of the district used only bio-fertilizer to the product the crops. The use of organic manures (farmyard manure, compost, green manure, and cow dung) is the oldest and most widely practiced means of nutrient replenishment in the study area. But now green manuring is almost absent in the district. Prior to the 1960s, organic manures (especially cattle dung) were almost the only sources of soil and plant nutrition. But the proportion of cattle manure available for fertilizing purposes decreased from 50 per cent in the early 1980s to 40 per cent in the early 2000s. And about 10 per cent of the total farmers are using organic fertilizer in their agricultural land. In the district, the cow dung and other organic sources are a very limited and not proper technique of compost making. For these reasons, farmers ordinarily use chemical fertilizer without any detonating the soil fertility status. Table 5.13 shows the percentage use of chemical and organic fertilizer in Uttar Dinajpur District.

Table 5.13 Use of chemical and organic fertilizer (in percentage) of Uttar Dinajpur District.

Chemical fertilizer use (%)	Organic fertilizer use (%)	Total (%)
89.44	10.56	100.00

Source: Based on derived from 360 respondents.

Chemical fertilizer was applied for the production of different types of crops like; paddy, wheat, maize, potato, jute and vegetables. The farmers of the district responded that the use of chemical fertilizers is able to increase the yield rates of the land. From the table 5.15, it is evident that 89.44 per cent of the total farmers of Uttar Dinajpur District are using chemical fertilizer. Because it is more effective and prompt work for plant growth as well as HYV seeds. The rest of the 10.56 per cent (38 farmer households) of the district farmers are using bio-fertilizers. They are not introduced to chemical fertilizers and they do not know the good results in higher production.

During the study period of about twenty-five years, the use of chemical fertilizers in the agricultural lands has been seen almost five and a half times increase. Mostly, the use of chemical fertilizer should be made in altered stages of growth of crops and till it matures. But in the district farmers use chemical fertilizers only once during the period of transplantation, weeding and distressing of the crops. It is not a scientific way and this practice fails to provide the required yield rate of crops. Year-wise consumption of chemical fertilizers like; Nitrogen (N), Phosphorus (P) and Potassium (K) and their trends in the district are presented in the table 5.14 (Appendix Va).

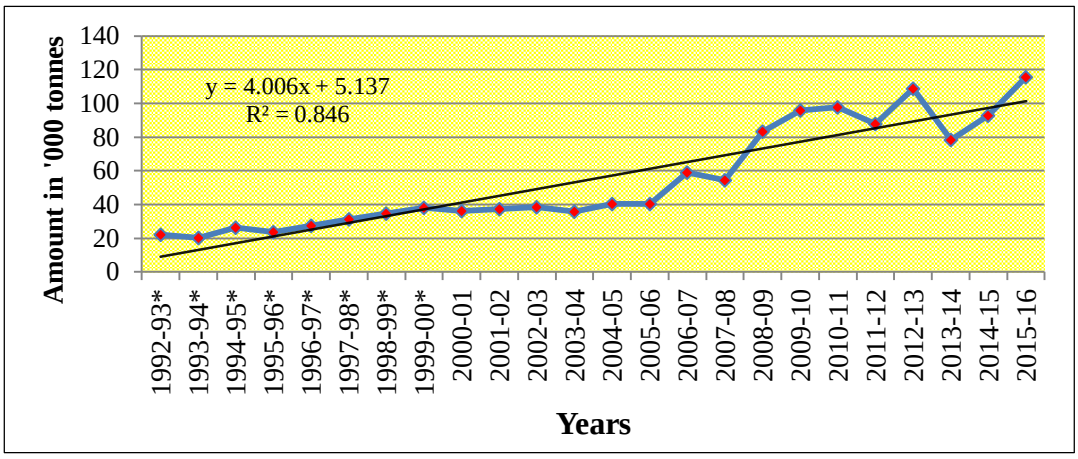


Figure 5.3 Changing trends of use of chemical fertilizer in Uttar Dinajpur District.

The data reveals that the consumption of chemical fertilizers i.e. N_2, P_2O_5, K_2O in the district. The use of chemical fertilizer varies one year to another year of the district due to lack of farmer's awareness, depend on the availability of fertilizers and economic instability. In 1992-93 total chemical fertilizer nitrogen (N), Phosphorus (P_2O_5) and potassium (K_2o) was only 10.80 thousand tonnes 5.70 thousand tonnes and 5.50 thousand tonnes respectively. It increased to 17.50 thousand tonnes 11.20 thousand tonnes and 7.60 thousand tonnes respectively during 2000-01. But it has again increased to 66.50 thousand tonnes, 29.60

thousand tonnes and 19.60 thousand tonnes in 2015-16. Total chemical fertilizer use increased from 22.00 thousand tonnes in 1992-93 to 115.70 thousand tonnes in 2015-16 overall the study period in the district. It indicates the tremendous rates of chemical fertilizers are used in agriculture sectors and thereby increase of the production and productivity per hectare. In the district, farmers are used different types of chemical fertilizers like; Urea, DAP, Potash, Phosphate, Sufala (10:26:26 and 10:15:15) and it had been available in the local market. However, the cost of these fertilizers is very high and the farmers are not able to buy the high cost of fertilizers. During the study period, Nitrogen (N) is the highest percentage consumption 54.32 per cent, Phosphorus (P) is 27.08 per cent and Potassium (K) is 18.59 per cent used in the whole district. It will give more clear pictures about the crop-wise uses of NPK dosage kg/hectare in the district and it is considered in the table 5.15.

Table 5.15 Crop-wise usage of average NPK dosage in Uttar Dinajpur District. (kg/ha)

Name of the crops	**Nitrogen (N)**	**Phosphorus (P_2O_5)**	**Potassium (K_2O)**	**Total = ($N+P_2O_5+K_2O$)**
Paddy	75.00	37.50	33.75	146.25
Wheat	97.50	48.75	29.00	175.25
Jute	60.00	32.50	23.75	116.25
Maize	38.25	29.45	28.50	96.20
Potato	78.70	35.80	45.00	159.50
Mustard	70.00	31.25	28.75	130.00

Source: Based on a household survey of 322 respondents.

The average highest nitrogen and phosphorus used in wheat is 97.50 kg and 48.75 kg/ha crop area respectively in the district. But the highest potassium (45.00 kg/ha) used in the potato field and lowest potassium used in jute (23.75 kg/ha). Not only that, the highest 175.25 kg/ha NPK used also in wheat and lowest 96.20 kg/ha in a maize field in the district. More chemical fertilizers use depends on the various factors like; availability of irrigation system, farmer's proper idea on usage of dosages of chemical fertilizer in different crops, transport facilities, availability of fertilizers selling outlets and proper transportation system. The use of chemical fertilizers plays a major role in pushing up agricultural production.

The other important factors of fertilizer used depends on availability of fertilizers, availability of fertilizer depots and availability of transport facilities. The fertilizer contact was measured in the primary survey based on the household's survey of 322 respondents to the author's required questions (use chemical fertilizer) and rest are not use chemical fertilizer. The level of fertilizer contact considered five categorizes i.e. very simple (<2 km), simple (2-4 km), medium (4-6 km), difficult (6-8 km) and very difficult (>8 km) are represented in the table 5.16.

Table 5.16 Block-wise fertilizers contact in Uttar Dinajpur District.

Name of the C.D. Blocks	Percentage of the total households					
	Very simple	**Simple**	**Medium**	**Difficult**	**Very Difficult**	**Total**
Chopra	8.82	32.35	47.05	5.89	5.89	100
Islampur	13.15	26.31	44.73	13.15	2.63	100
Goalpokher-I	5.88	23.53	38.23	20.59	11.76	100
Goalpokher-II	9.68	29.03	48.39	6.45	6.45	100
Karandighi	-	33.33	30.55	25.00	11.11	100
Raiganj	10.00	27.50	47.50	12.50	2.50	100
Hemtabad	13.89	25.00	58.33	-	2.78	100
Kaliaganj	5.40	35.13	48.64	2.70	8.11	100
Itahar	13.89	27.78	33.33	19.44	5.55	100
Uttar Dinajpur	**9.00**	**28.88**	**44.09**	**11.80**	**6.21**	**100**

Source: Based on the households survey of 322 respondents.

It is clear from the table 5.16 the fertilizers contact problems faced by the farmers in the different blocks of Uttar Dinajpur. It is observed that 29.41 per cent of farmers in Goalpokher-I Block have very simple and simple fertilizers contact. It is also observed that 11.76 per cent of the block farmers have very difficult fertilizer contact. 41.67 per cent of the farmers in Itahar Block have very simple and simple fertilizer contact. It is the discussing matter that in Karandighi Block no farmers have very simple fertilizer contact. All over the block, it is the good situation in Raiganj Block only 2.50 per cent of the block farmers have very difficult fertilizer contact. About 37.88 per cent of the total farmers are access to the fertilizer contact very easily and easily in the district. 18.01 per cent of the total farmers of the district have difficult and very difficult fertilizers contact. So, farmers are not getting easily used of chemical fertilizer. Rest 44.09 per cent of the total district farmers have medium fertilizer contact. It is a fact that the district's farmers are not satisfied to properly use of the chemical fertilizers to their agricultural fields. Because of per hectare crop production rate is far below to the other district of West Bengal. This analysis is unable to provide an insight regarding the fertilizer depot density. Fertilizer contact of the farmers depends on the distribution of the fertilizers depots. So, considered of the fertilizer's outlets density in each block for the year 2015-16 shown in the table 5.17.

Table 5.17 Block-wise fertilizers depot density of Uttar Dinajpur District.

Name of the C.D. Blocks	Number of Fertilizer depots	Fertilizer depots/ '000 hectares
Chopra	132	3.51
Islampur	139	4.21
Goalpokher-I	161	4.64
Goalpokher-II	96	3.21
Karandighi	143	3.83
Raiganj	278	5.97
Hemtabad	137	7.18
Kaliaganj	219	7.27
Itahar	369	10.00

Uttar Dinajpur	**1,674**	**5.48**

Source: Office of the Principal of Agriculture officer (PAO), Karnojora, Uttar Dinajpur.

Among the 9 Blocks of Uttar Dinajpur District, the fertilizer depot density or fertilizer depots per thousand hectares are comparatively high in Itahar Block i.e. 10 fertilizer depots per thousand hectare area. The other three blocks namely; Raiganj, Hemtabad and Kaliaganj fertilizers depots density per thousand hectares are 5.97, 7.18 and 7.27 respectively and it is far high from the district average i.e. 5.48 per thousand hectares. Rest of the five blocks in the district namely; Chopra (3.51/'000 ha), Islampur (4.21/'000 ha), Goalpokher-I (4.64/'000 ha), Goalpokher-II (3.21/'000 ha) and Karandighi (3.83/'000 ha) fertilizer depots density are the far below of the district average. It may also be observed that in these five blocks farmers are cannot take easily their weighty fertilizers. So, they are not gaining proper crop production in per hectare area.

5.4.1 Role of chemical fertilizers in yield rates

The use of chemical fertilizers rapidly increased over the district from 1991-92 to 2015-16. Because of the modernization in agricultural sector by the farmers and population pressure, the agriculture is bound to increase the crop production which is not fulfilled without chemical fertilizers. However, the cost of chemical fertilizers is high and small and poor farmers are not able to pay the high cost. The use of chemical fertilizers and its effective change in per hectare production, actual plant growth characteristics and yield rate of paddy, wheat, maize, potato were considered in table 5.18.

Table 5.18 Plant growth and yield rate change for using chemical fertilizer in 2017

Usage of fertilizers	Plant height (cm)				Average yield rate kg/hectare			
	Paddy	Wheat	Maize	Potato	Paddy	Wheat	Maize	Potato
50% cow dung +50% NPK	**65-70**	**60-65**	**160-170**	**35-40**	**2,550**	**2,500**	**4,600**	**25,500**
100% cow dung	60-65	55-60	150-155	30-35	2,400	2,450	4,450	24.000
100% NPK	**75-80**	**70-75**	**175-180**	**40-45**	**2,800**	**2,800**	**5,800**	**30,000**
100% bio-fertilizers	65-70	55-6-	165-170	35-40	2,450	2,500	4,400	26,000
No Fertilizer	**60-65**	**50-55**	**150-155**	**30-35**	**2,300**	**2,150**	**4,175**	**21,000**

Source: Researcher's field survey report based on 450 crop plots results.

The integration of chemical fertilizers (NPK) with cow dung increased the paddy, wheat, maize and potato plant heights to the same level as the height in response to the no fertilizer use and bio-fertilizer use. Application of 50 per cent cow dung and 50 per cent NPK resulted

in paddy and other crops plants that were as tall (paddy 65-70 cm, wheat 60-65 cm, maize160-170 cm, and potato 35-40 cm) as those resulting from the lone NPK fertilizers application. On the other hand, fertilizer usage of 100 per cent cow dung use resulted in the same i.e. paddy and others crops plant heights (paddy 60-65 cm, wheat 55-60 cm, maize 150-155 cm and potato 35-40 cm) as those resulting from the usage of 100 per cent NPK. But in yield rate of crops picture is application of 50 per cent cow dung and 50 per cent NPK resulted in paddy and other crops yield per hectare that were as increased (paddy 2,550 kg, wheat 2,500 kg, maize 4,600 kg, and potato 25,500 kg) as those resulting from the lone NPK fertilizers application is paddy 2,800 kg, wheat 2,800 kg, maize 5,800 kg and potato 30,000 kg per hectare (table 5.18).

5.5 Use of pesticides and its effect on production and environment

A vast majority of the population in Uttar Dinajpur District are engaged in agricultural and are, therefore, exposed to the pesticides used in agriculture. Pesticides have become an integral part of modern farming, with most crops receiving at least one and usually many more applications. In the district, as the value of a crop increases, so does the amount of pesticide used with 8 to 10 applications per year being normal for some vegetables and fruits. Chemical pesticide use is connected with risk and humanoid health hazards if not handled correctly by the farmers. Improper handling and insecure spraying of the agrochemicals reason a high risk of health hazards reported in the earlier studies (Bag, 2000 and Gupta, 2004). Pesticides reduce attack by pests, sicknesses and weeds and contribute to advanced yields, improved quality and higher economic earnings. The use of pesticides is one of the most important contributors to increased agricultural production since the 1970s in the district.

5.5.1 Pesticides usage in the district

Pesticides are used to control a wide range of agricultural pests, diseases and weeds. They are also present in a number of veterinary products to control some of the ecto and endo parasites encountered in livestock farming. In the district, the farmers generally use two types of pesticides like; liquid and powder. There are many different types of pesticides on the markets today, but in the district's most of the common pesticides are herbicides and insecticides, which manage unwanted plants and kill crops deleterious insects. Over the last decades, widespread use of pesticides has several benefits and also caused many problems in agriculture sectors as well as the environment. In the study area, the use of common pesticides in the agricultural field and their target organism are presented as in the table 5.19.

Table 5.19 Use of common pesticides and their target organisms in Uttar Dinajpur District.

Types of pesticides	Target organism	Examples of active ingredients
Bactericide	Bacteria	Matiram, Difolatan
Fangicide	Fungi	Phenylamides, Dicarboxamides
Harbicide	Plants	Atrazine, 2D-4D, Acifluorfen
Insecticide	Insects	Dimethoate, Permethrin

Source: Agricultural Pollution: Environmental Problems and Practical Solutions.

Pesticides consumption in the district is medium, less than 1.8 kg per hectare against 16 kg per hectare in West Bengal. The production of pesticides started in the study area in 1970s with the establishment of a plant for the production of wheat. There has been steady growth in the production and use of pesticides in Uttar Dinajpur from 56 tonnes in 1970 which increased 216 tonnes in 1990 and 562 tonnes in 2015. The farmers of the district are using started a vast amount of chemical pesticides in different crops after the 1990s. The pattern of pesticides used in the district is differing from the West Bengal. As can be seen in the table 5.20 in the district 78 per cent of the total pesticides are used in insecticides, as against 75 per cent in West Bengal. And 9 per cent of the total pesticides are used in herbicides, 13 per cent of pesticides are used in fungicides and rest 2 per cent of pesticides are used on another purpose (PAO, Uttar Dinajpur District).

Table 5.20 Percentage of pesticides usage pattern in Uttar Dinajpur District.

Pattern of Pesticides	% of Pesticides
Insecticides	78.00
Herbicides	9.00
Fungicides	13.00
Others	2.00
Total	100.00

Source: Office of the Principal of Agriculture Officer, Karnojora, Uttar Dinajpur.

The main usage of pesticides in the district is for different crops namely; paddy (33.00 per cent), wheat (8.75 per cent), potato (21.20 per cent), maize (10.20 per cent), vegetables (24.80 per cent) and others (2.05 per cent) (PAO, 2015). Pesticides are the compulsory inputs which are basically used in the production of HYV crops. HYV crops are very responsive and responsible to be attacked by the insect and diseases against this pesticide are used. Pesticides are an important ingredient in agricultural sectors for disease-less crop production. In this situation, the block-wise percentage of pesticide usage of different crops is considered in the table 5.21.

Table 5.21 Crop-wise use of pesticides in Uttar Dinajpur District (2015-16).
(figure in percentage)

Name of the C.D. Blocks	Paddy	Wheat	Potato	Maize	Vegetable	Others	Total (%)
Chopra	29.12	8.44	23.96	11.20	23.60	3.68	100
Islampur	35.38	9.25	19.10	9.60	26.00	0.67	100
Goalpokher-I	30.79	6.82	22.12	9.25	28.70	2.32	100
Goalpokher-II	37.50	7.90	18.88	9.12	23.95	2.65	100
Karandighi	28.52	8.76	17.36	10.13	32.70	2.53	100
Raiganj	33.10	10.36	25.20	12.19	17.20	1.95	100
Hemtabad	36.21	9.10	19.78	8.88	23.48	2.55	100
Kaliaganj	30.66	9.80	20.26	9.06	26.78	1.87	100
Itahar	34.74	8.32	24.14	12.37	20.79	0.23	100
Uttar Dinajpur	**33.00**	**8.75**	**21.20**	**10.20**	**24.80**	**2.05**	**100**

Source: Office of the Deputy Director of Agriculture (Administration), Karnojora, Uttar Dinajpur District.

A Block-wise comparison shows the pesticide use in paddy field is 37.50 per cent highest in Goalpokher-II Block and it is important that in four blocks namely, Islampur, Raiganj, Hemtabad and Itahar percentage of pesticides use is far higher than the district's average. While the rest four blocks namely, Chopra, Goalpokher-I, Karandighi and Kaliaganj percentage of pesticides use far below the district average i.e. 33.00 per cent. The second highest percentage uses of pesticides are in vegetables. In the study area, block-wise percentage share of pesticides use is highest in Karandighi Block (32.70 per cent) and the lowest is in Raiganj Block (17.20 per cent). Pesticides use is high in Karandighi Block because, in this block, the farmers produce the highest volume of vegetables per hectare in the district. So, farmers use more pesticides in vegetable fields. More than 50.00 per cent of pesticides are used of the district in paddy and vegetable fields. For this regards liquid pesticides are comparatively more used in the district. Different types of pesticide are used in Uttar Dinajpur District shown in the table 5.22.

Table 5.22 Block-wise types of pesticides used in Uttar Dinajpur District.

Name of the C.D. Blocks	Liquid (%)	Dust (%)	Both (%)	Total (%)
Chopra	55.00	35.00	10.00	100.00
Islampur	57.50	40.00	2.50	100.00
Goalpokher-I	62.50	20.00	17.50	100.00
Goalpokher-II	65.00	22.50	12.50	100.00
Karandighi	45.00	40.00	15.00	100.00
Raiganj	50.00	32.50	17.50	100.00
Hemtabad	60.00	32.50	7.50	100.00
Kaliaganj	50.00	30.00	20.00	100.00
Itahar	67.50	25.00	12.50	100.00
Uttar Dinajpur	**56.16**	**30.41**	**13.43**	**100.00**

Source: Based on the households survey of 360 respondents.

From table 5.22 it is clear that, most of the (56.16 per cent) farmers of the district use liquid pesticides in agricultural sector to protect the crops. Because liquid pesticides are more effective and give prompt result for the killing insecticides than dust pesticides. Not only that,

it is easy to use, coverage more cropped area and cost is lower than the dust pesticides. Only 30.41 per cent of the total farmers have used dust pesticides in their crops and 13.43 per cent of total farmers have used both types of pesticides in the district. Dust pesticides are very costly pesticides and it is not available in the market at the time of requirement (cropping seasons). On the other hand, it works slowly and farmers are bound to use in the growing time as well as rainy days. Liquid pesticides are not sprayed on rainy days because it is washed due to rain.

5.5.2 Effect of pesticides on production

Although earlier collectively referred to as pesticides, these chemical include herbicides, insecticides and fungicides. The use of pesticides plays a vital role in the control of weeds and pests, and together with the use of fertilizers. Now-a-days pesticides are important in modern intensive agriculture. Without pesticides use, it has been estimated, the cereal crop would fall by 24 per cent during the first year and by as much as 45 per cent in the third year (Royal commission on environmental pollution-1979). If pesticides were not used in Uttar Dinajpur agriculture system, crop lost would be about 21 per cent and amount as much as about Rs. 1,930 lakhs (approximately) per annum (PAO, Uttar Dinajpur District).

On the other side, the criticism of pesticides and their agricultural use have been focused at the chlorinated hydrocarbons such as DDT. Although attempts have been made to contract with the problems arising from DDT and other early pesticides, the use of farm chemicals static gives cause for some concern. Several insect pests develop resistance and increasing doses and new categories of chemicals are essential to achieve pest control. Side effects on harmless species and on adjoining areas result increasingly. As a result crop production declines day-by-day. Because the usefulness species are demolished in the agrarian sector (Mather, 1986).

5.5.2.1 Effect of pesticides on productivity in the District

The primary advantage is the outcome of the pesticide's effects in the straight gains expected from there uses. The effect of killing silk warms feeding on the crop brings the primary advantage of higher yields and better quality of cauliflower. The other benefits are the less immediate benefits which result from the primary benefits. There are various secondary benefits of pesticides in agricultural sectors. These are discussed below:

a) Production increasing

Remarkable advantages have been derived from the use of pesticides in the agricultural sector which the increasing per capita income of farmers. In the study area, total production in 2001

was 1393.60 thousand metric tonnes but it has increased in 2016 almost two-fold to 2090.80 thousand metric tonnes. Pesticides have been an integral part of the process by reducing losses from the weeds, decreases and others. Not only that, an increase in production has been due to several factors including HYV seeds, fertilizers and the use of modern machinery. Lastly, it can be said easily that, the production of crop in the districts increases day to day. Increasing the structure of productivity in different crops in the district is shown in the table 5.23.

Table 5.23 Growth of major crop production in Uttar Dinajpur District (2001-2016).
(Production in '000 metric tonnes)

Years	Foodgrains	Oilseeds	fibber	miscellaneous	Total crops
2001	721.10	32.40	473.70	166.40	1393.60
2002	699.30	29.70	642.20	125.70	1496.90
2003	697.70	21.80	605.90	236.00	1561.40
2004	821.20	32.30	700.40	172.30	1726.20
2005	806.70	35.00	667.10	174.90	1683.70
2006	827.50	27.80	673.50	172.00	1700.80
2007	741.20	20.70	667.70	116.90	1546.50
2008	846.00	25.80	631.70	255.60	1759.10
2009	894.60	33.60	590.40	225.10	1743.70
2010	849.60	42.80	564.70	291.90	1748.70
2011	914.80	36.50	571.90	444.30	1967.75
2012	893.50	34.90	611.70	437.70	1977.78
2013	890.70	43.00	584.90	468.00	1986.60
2014*	898.60	47.50	593.70	489.10	2028.90
2015*	918.10	57.40	607.20	501.30	2084.40
2016*	922.70	57.00	606.10	505.00	2090.80

Source: i.* Directorate of Deputy Agriculture Officer, Karnojora, Uttar Dinajpur
ii. Districts Statistical Hand Book, Bureau of Applied Economics and Statistics, Government of West Bengal, Kolkata, 2001-2013.

b) Crops disease control

Insecticides are often the only practical path to control the insects which spread deadly diseases in crops. Disease control strategies are a must need for the proper growth of crops.

c) Prevention of crop damage

Pesticide powerfully saves crops damage. In general land, potato even under pool situation during the critical time warranted on effective and economical weed control practice to obstruct reduction in potato field due to weeds that range from 28 to 48 per cent (Behera and Singh, 1999). Normally pesticides in the early stages of a crop establishment produces reduction in damage up to 40 per cent. However, herbicides provides together and economic and labour profit to the farmers. Now-a-days, pesticides are common features for profitable crops. Not only that, pesticides used in crop fields for higher production in per hectare area.

d) Increases food quality

Pesticides on one side, conservation from insecticides and another side it gives us high quality of crops. High quality of crops gets high paddy in the market. Lewis, et al, (2005) discussed the nutritional of food in the US diet and decided that their high concentrations of anti-oxidants act as to guard against cancer and heart disease.

5.5.2.2 Effect on environment

In the agricultural system, pesticides are sprayed over a large area of land. In Uttar Dinajpur districts about 3,643 quintals dust pesticides are used in the agricultural field and 4,372 litres liquid pesticides used in 2015-16 (PAO, Uttar Dinajpur) of different crop seasons. Pesticides are applied over large tracts of agricultural land and carried away by the wind and water runoff. As a result, the pesticides travel to the other areas and affect ponds, soil and water. Additionally, storage, transportation and production allow some quantities of pesticides to be introduced to the environment. In the district, the effect of pesticides on the environment discusses in three ways, like;

a) Effect of pesticides on soil

Farmers of Uttar Dinajpur District use pesticides in tremendous doses on the plant for the destroyed of harmful insects. Pesticides once applied to crops, it works their way into the soil, where it has devastating effects. Because of this the soil has a lower quality i.e. loss of its fertility day-by-day and removal of a large percentage of organic matter from the soil. Not only that, organic element helps the soil retain water, which can be highly assistant for agricultural works, especially at the time of droughts season. More pesticides use in plant soil has less fertile and less fertile soils which mean less plant growth. As a result, the growth of less plant gives less productivity of crops.

b) Effect of pesticides on ground water

In the study area, soil porosity condition is well. Pesticides percolate into the soil and trace their path into ground water. Over the past two decades, pesticides and their transformation products have been tracked out in ground water. Most of the disappointing matter that, there are 98 pesticides and 13 transformation products that have been tracked out in ground water in the district (Agriculture Mechanization Department, Karnojora). These pesticides are also easily carried on ground water. Pesticides that have been detected more frequently (table 5.24) include those have been used more widely, such as the Carbamates, Triazines, Fumigants and fungicides, etc. Pesticides and their transformation products are generally present at low

concentrations in ground water beneath agricultural areas and some seldom at concentrations that exceed water-quality standards. The proportions of pesticide concentration in sample wells (total 1,032 wells sampled in Uttar Dinajpur by WRIDD) focused mainly on agricultural areas in the district ranges from 5-60 per cent (Rural areas). Pesticides concentrations were 1 ug/l or less in over 92 per cent of the sampled wells in the district. In the district, different types of pesticides were found in sampled wells. There are Fumigant (EDB, DBCP, Dichloro propane), Triazines (Atrazine, Simazine, Metribuzinete), Acetanilides (Alachlor, Metolachlor), Carbamates (Aldicarb sulfone, Aldicarb, Carbaryl, etc.), Herbicides (Bromacil, Diuron, Linuron, etc.), Insecticides (Oxamyl, Methomyl, DDT) and Fungicides (Pentachloro phenol and Arsenic). In this regards, block-wise percentage of sample wells frequencies of different pesticides detection in ground water shows in the table 5.24 (Appendix Vb).

From the table 5.24 it is clear that the concentration of pesticides and its transformation product dissolved more than the sampled wells. In the district total 21 types of pesticides are found and EDB pesticides are detected in about 75 per cent sampled wells. About 71.52 per cent DBCP, 51.65 per cent Atrazine, 51.26 per cent Dichloro propane, 65.68 per cent Aldicarb sulfone, 62.20 per cent are Aldicarb sulfoxide and 58.82 per cent Carbofuran is found in sampled wells of the whole district. Pesticides affected earthworms, Juvenile population decline, vertebrate immune systems, egg shell thinning in raptorial birds, reduced food availability and adverse secondary effects on soil invertebrates and butter flies and many others. So, it is dangerous for human health and irrigation.

c) Effect of pesticides on air

Pesticides can also contribute to air pollution and also easily carried on the wind to other, non-agricultural areas, in a phenomenon known as pesticides drift. Pesticides drift occurred when it suspended in the air as particles are carried by wind to other areas. Pesticides are sprayed on to the fields and used to fumigate soil can give off chemicals called volatile organic compounds, that can react with other chemicals and form a pollutant called tropospheric ozone. Some pesticides ingredients stay in the atmosphere for only a short period of time and others can last longer. Pesticides leave the remarkable target; it can be steered across a long distance, potentially entering delicate ecosystems. The distance which these pesticides can travel depends on wind speed, relative humidity level and external temperatures.

5.6 Agricultural productivity

Agricultural productivity is measured as the ratio of agricultural output to agricultural inputs. Uttar Dinajpur districts have witnessed tremendous changes in agriculture and allied sectors

since the independence time; it has registered imbalanced agricultural development and spatial variations in productivity. In the district, about 70 per cent of the working population is engaged in the agricultural sector either as cultivators or as agricultural labours. Agriculture in the district is backward in comparison with that of the other district of West Bengal. Geographical studies on agricultural productivity are largely associated with its regional variations (issues related to the environmental condition and productivity pattern), its assessment (methodological aspects of production measurement) and applied aspects (issues related to the determination of productivity factors such as biological, techno-economic, demographic and socio-cultural in the specific environment of land). Although agricultural productivity differs from one region to another region, and the factors for such variations are many, the determination of variations in agricultural productivity and their possible reasons help to demarcate the regions of agricultural productivity. The main issue in Uttar Dinajpur District is to analyse the productivity pattern in relation to bio-physical factors of land and agricultural intensity in order to understand of agricultural development.

5.6.1 Different approaches for the measurement of agricultural productivity

Agricultural productivity dimension is not a simple task as it deals with establishing a relationship among output and input in farming production. Agricultural productivity has been evaluated and studied by considering physical influences of land productivity and work force involved in agrarian operation (Rehman and Singh, 1992). In modern times agricultural productivity has involved the consideration of geographers working in several disciplines like; geography, agricultural sciences economics and agricultural economics for a extensive time; various attempts have been made to measure and classify agricultural productivity in India as well as other countries in the world. Determining productivity in farming is substantial literature connecting to methodological processes. The actual measurement of farming productivity which is the utmost regularly used are those of incomplete productivity and refers to the relative of a sole input to the entire output. There are more than 25 methods to find out the agricultural productivity. Among these, most essential approaches are discussed below-

Thompson (1926) measures the qualified productivity of British and Danish farming emphasized and expressed of gross yield of crops and livestock. In this regard, he considered seven parameters, like;

a) The yield rate per acre of crops.
b) The gross production per 100 acres.
c) The livestock per 100 acres.

d) The proportion of arable land.
e) The number of employed persons.
f) The cost production, i. e. wages and labour costs, rent or interest.
g) Paddy relative profitability and general economic conditions.

Enyedi (1964); Shafi (1972, 1984) influential an index of productivity coefficient. Enyedi's formula of productivity index is-

Productivity index = (Y/Yn) ÷ (T/Tn)

Where, Y is the total production of the selected crop in a unit area.

Yn is the total production of the same crop on a national scale.

T is the total cropped area of the unit area and

Tn is the total cropped area on a national scale.

The procedure of Enyedi's is relevant for determining the productivity index of an area with the reference to the nation-wide level. The most interesting thing is that the technique does not calculate in certain cases the productivity index is influenced by the extension of the area under a particular individual crop. When the district yield rate is less than the national yield rate, its productivity index is also higher than the national level.

Jasbir Singh (1976) has attempted to measure the local changes in the level of food manufacture and to demarcate the weaker areas from the point of view of agrarian production is sufficient to focus consideration on essential food crops in a specific region and its dominant primary and secondary crops in relations of agrarian land occupancy. For the measurement of the equality of agricultural productivity, the crop yield and crop concentration indices arranged in ranking order and computed into average ranking coefficients, would give a measure, i.e. called the crop yield and crop concentration indices. The formula would be read thus-

Yi = Yac / Yar x 100

Where, Yi is the crop yield index.

Yac is the average yield per hectare of crop 'a' in the component prediction units.

Yar is the average yield of crop 'a' in the whole region.

Or, **Ci = Pac/ Par x 100**

Where, Ci is the crop concentration index.

Pac is the percentage share of crop 'a' in the total harvested area in the component enumeration on unit and

Par is the percentage share of crop 'a' in the total harvested area in the whole region.

Bhatia (1967) standardized yield index shows the fluctuations and trends in agriculture efficiency in Uttar Pradesh in the year 1953-1963 accepted Ganguli's technique of productivity measurement and has devised calculation i.e. would be read thus

i) **Iya = Yc/Yr x 100**

Where, Iya is the yield index of crop 'a'.

Yc is the average acre yield of crop 'a' in the part unit; and

Yr is the average acre yield of crop 'a' in the whole region.

On the other way-

$$\text{ii) } \mathbf{Ei} = \frac{\mathbf{Iya.\ Ca + Iyb.\ Cb + \ldots\ldots\ldots\ldots\ldots\ Iyn.\ Cn}}{\mathbf{Ca + Cb + \ldots\ldots\ldots\ldots\ldots\ldots\ Cn}}$$

Where, Ei is the agricultural efficiency index.

Iya, Iyb and continue is the indices of various crops and

Ca, Cb, etc. represent the proportion of crop land devoted to different crops.

Singh (1972) has evolved a new technique for the measurement of agricultural efficiency, which consists of the measurement of carrying capacity per unit area in terms of population in relation to output per unit area. The method would be read in the equation form as:

Cp = Co/Sn

Where, Cp = Carrying capacity.

Co = Calorie output per mile and

Sn = Proper nutrition per person/annum.

But he expounded it as a percentage of the carrying capacity in the whole area to obtain index numbers, which can measure the agricultural efficiency of the areal unit to the whole region. It can be expressed as:

Iac = Cpe/Cpr x 100

Where, Iac is the index number of agricultural efficiency of a prediction unit.

Cpe is the carrying capacity in terms of population in the component prediction unit.

Cpr is the carrying capacity in the whole region.

Yang (1965) devised a 'crop yield index' method that was applied for agricultural productivity. The agricultural productivity indices of crops were calculated. His method represents the yield rate of various crops in blocks compared with the average crop yield of the district. The procedure for calculating 'crop yield index' is-

Firstly, the average yield of each crop grown in the whole region is determined. And secondly, the value of each crop is divided by the yield of the whole region then multiplied by 100 and get the value in per cent (shown in col. 5, table 5.25). By considering the area devoted to each crop as weight and multiplying it with the percentage value, a product is obtained (shown in col. 6, table 5.25). By adding the products and dividing the sum of the products by the total crop area (hectares).

5.6.2 Yang's crop yield index method of agricultural productivity (1965)

The study of agricultural productivity of the study area, Yang's crop productivity index technique has been used. In this technique, selected major crops grown in the district were considered for productivity examination. The actual area and an average yield rate of altered crops have been taken into account to compute the agricultural productivity results given in table 5.25.

Table 5.25 Method of calculating crops productivity index of Chopra Block, Uttar Dinajpur District, for the year of 1990-91

Name of the selected crops	Average yield rates (Quintal/ha)		Area of each crop in the block (ha)	Crop yield in the block as % of the district (col.3/col.2)x100	Percentage multiplied by the area under crops (col.4xcol.5)
	Yield in district	Yield in blocks			
1	2	3	4	5	6
Paddy	23.40	25.45	13,580	108.76	1,476,960.80
Wheat	16.75	18.10	2,015	108.05	2,17,720.75
Potato	72.00	67.75	3,140	94.09	2,95,442.60
Gram	5.60	4.78	570	85.35	48,649.50
Maize	41.90	44.50	890	106.20	94,518.00
Mustard	9.35	10.20	285	108.85	31,022.25
Total			**20,480**	**-**	**2,164,313.90**

Source: PAO, Uttar Dinajpur.

Crop yield index for Chopra Block is-

Summation value of column 6/ Summation value of column 4

= 2,164,313.90/20,480

= 105.68

5.6.2.1 Agricultural productivity region-based on cereal crops

In the district, cereal crops occupy a significant position in the agricultural sector. The major cereal crops in the district like; *paddy, wheat, maize, bajra* and *barley* which occupy a

significant position. The computed values of productivity index for nine blocks of Uttar Dinajpur are given in the table 5.26. Area of very high, high, medium, low and very low productivity zone of cereal crops are shown in figure 5.4.

Table 5.26 Agricultural productivity index for cereal crops.

Name of the C.D. Blocks	Yield index (1990-91)	Yield index (2015-16)	Growth per annum
Chopra	102.12	141.32	1.57
Islampur	98.45	129.48	1.24
Goalpokher-I	97.65	122.35	0.99
Goalpokher-II	100.15	143.90	1.75
Karandighi	103.34	139.65	1.45
Raiganj	106.18	137.02	1.23
Hemtabad	95.14	129.30	1.37
Kaliyaganj	90.76	119.26	1.14
Itahar	109.42	160.25	2.03

Source: i. District Statistical Hand Book, Uttar Dinajpur District, Bureau of Applied Economics and Statistics, Government of West Bengal, Kolkata, 2015
ii. Directorate of Agriculture, Government of West Bengal, Uttar Dinajpur
iii. Researcher's calculation.

i. Very low productivity zone

In the district, very low productivity of cereal crops are limited in one block with an index value of below 94.49 in 1990-91 and in the year 2015-16 it is also covered two blocks namely Kaliaganj and Goalpokher-I with an index value of below 127.46 per cent (table 5.26).

ii. Low productivity zone

Low productivity cereal is observed in two blocks namely; Goalpokher-I and Hemtabad with the agricultural productivity index is 97.65 and 95.14 per cent in the year 1990-91 respectively. This zone is located in northern and south-eastern part of the district (figure 5.4-A). However, in 2015-16, it is limited to two blocks with a productivity index value namely; Islampur (129.48 per cent) and Hemtabad (129.30 per cent). This zone is located in northern (Islampur) and south-eastern part of the district (figure 5.4-B).

Table 5.27 Productivity region based on yield index of cereal crops in Uttar Dinajpur District (1990-91 and 2015-16).

1990-91				2015-16			
Productivity Category	**Crop index**	**No. of C.D. Blocks**	**Name of the C.D. Blocks**	**Productivity Category**	**Crop index**	**No. of C.D. Blocks**	**Name of the C.D. Blocks**
Very Low	<94.49	1	Kaliaganj	Very Low	<127.46	2	Kaliaganj, Goalpokher-I
Low	94.49-98.22	2	Goalpokher-I, Hemtabad	Low	127.46-135.66	2	Islampur, Hemtabad
Medium	98.22-101.95	2	Islampur, Goalpokher-II	Medium	135.66-143.86	3	Chopra, Karandighi & Riganj
High	101.95-105.68	2	Chopra, Karandighi	High	143.86-152.06	1	Goalpokher-II

Very High	>105.68	2	Raiganj, Itahar	Very High	>152.06	1	Itahar

Source: Computed by the researcher from the table 5.26

iii. Medium productivity zone

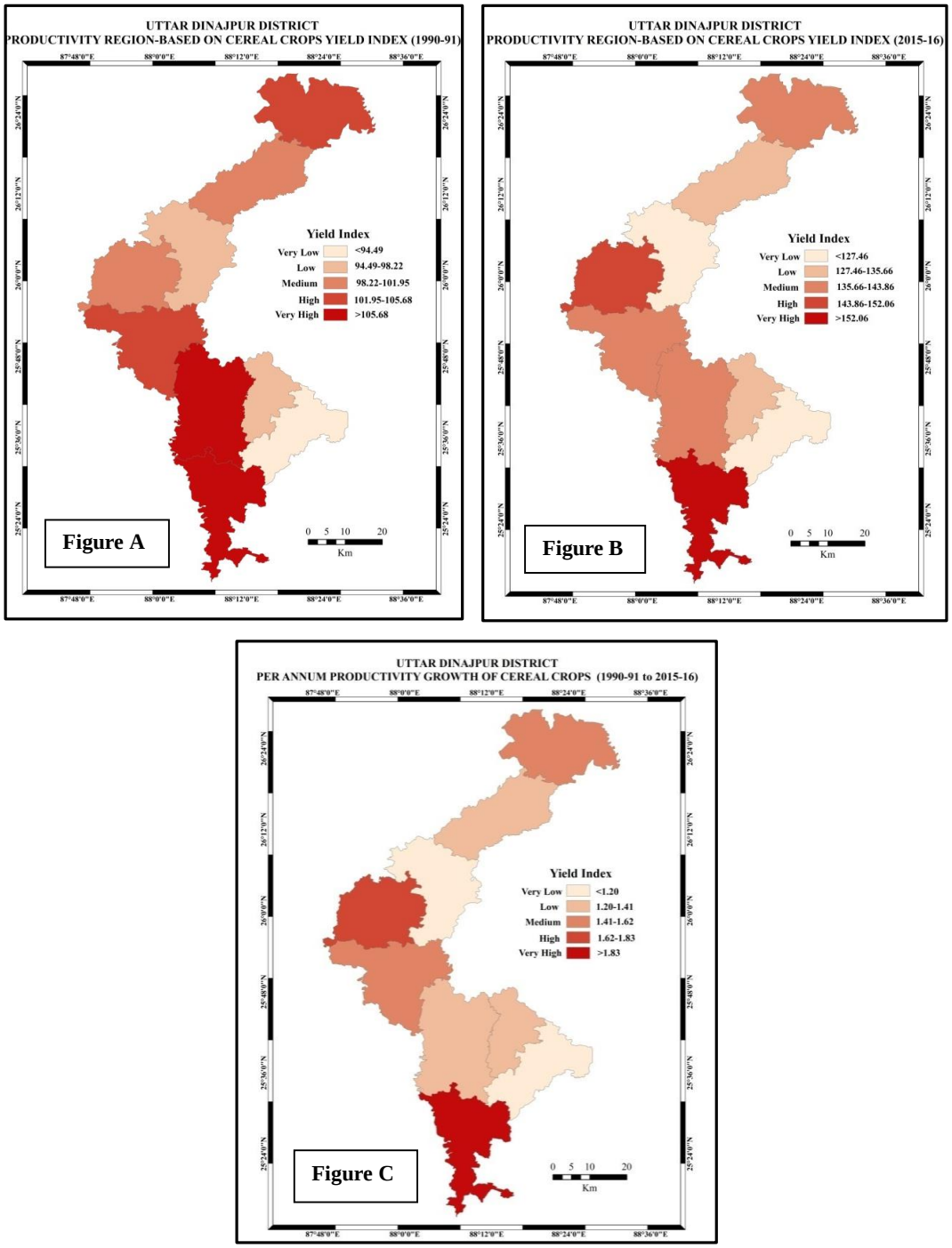
The medium productivity region in cereal crops (figure 5.4-A) lays in the North and Northern part of the district with a productivity index value ranges among 98.22 to 101.55 per cent in 1990-91. In the district, blocks having the moderate productivity are Islampur (98.45 per cent) and Goalpokher-II block (101.15 per cent). This zone lies in the northern part of the district. But in the year 2015-16, medium productivity zone is limited to three blocks with an index value ranging among 135.66 to 143.86 per cent. On the other side, in the year 2015-16, the medium productivity blocks are namely Chopra (141.32 per cent), Karandighi (139.65 per cent) and Raiganj (137.02 per cent). This zone lies in northern and middle part of the district (figure 5.4-B).

iv. High productivity zone

In the district, high productivity zone index values range between 101.95 and 105.68 per cent in 1990-91 and it is increased to 143.86 and 152.06 per cent in the year 2015-16. High productivity cereal crops limited are two blocks namely; Chopra (102.12 per cent) and Karandighi (103.34 per cent) in the year 1990-91. This region lies in North and South-western part of the district. On the other hand, in the year 2015-16, it limited is one block namely; Goalpokher-II with an index value is 143.90 per cent. This zone lies in the middle and western portion of the study area. Per hectare productivity rate is high because, difference in soil fertility, good accessibility of irrigation, use of HYV seed and additional circumstances available in this Block.

v. Very high productivity zone

During the year 1990-91, the maximum agricultural productivity is limited in two blocks, one is Raiganj (106.18 per cent) and another is Itahar (109.42 per cent). The very high productivity region in cereal crops (figure 5.4-A) lies in the central and southern part of the study area with a value of above 105.68 per cent. But in the year 2015-16, only one block namely; Itahar has high agricultural productivity (160.25 per cent) and it located in southern part of the study area. The very high productivity region with an index value is above 152.06 per cent in 2015-16 (figure 5.4-B).



Source: Prepared by the researcher based on crops productivity data.

Figure 5.4 Status of agricultural productivity of cereal crops (1990-91 to 2015-16).

5.6.2.1.1 Growth of agricultural productivity in Uttar Dinajpur District (1990-91 to 2015-16)

The growth of very high agricultural productivity index per annum is 2.03 (table 5.27) in between 1990-91 to 2015-16 recorded in Itahar Block. However, very low growth productivity index per annum is observed in Goalpokher-I (0.99 per cent) in the study area. The actual

growth of agricultural productivity for the period of the blocks in the study area between in 1990-91 to 2015-16 has been given in table 5.28. Per annum growth region distribution is shown in figure 5.4-C.

Table 5.28 Changes in per annum productivity of cereal crops (1990-91 to 2015-16).

Productivity Category	Crop index	No. of C.D. Blocks	Name of the C.D. Blocks
Very Low	< 1.20	2	Goalpokher-I, Kaliaganj.
Low	1.20-1.41	3	Islampur, Raiganj & Hemtabad.
Medium	1.41-1.62	2	Chopra, Karandighi.
High	1.62-1.83	1	Goalpokher-II
Very High	> 1.83	1	Itahar.

Source: Computed by the researcher from table 5.26

From the table 5.28, per annum moderate agricultural productivity index is observed in two Blocks namely; Chopra (1.57 per cent) and Karandighi (1.45 per cent). Low productivity growth per annum is observed in three Blocks with a yield index value namely; Islampur (1.24 per cent), Raiganj (1.23 per cent) and Hemtabad (1.37 per cent). Causes for low growth of productivity are low capability of soil fertility for production of cereal crops, non-availability of irrigation system and various factors.

5.6.2.2 Agricultural productivity zone-based on pulse crops

The productivity of pulses varies in different blocks of the district. It is a very significant crop in Uttar Dinajpur District. Now-a-days, farmers have lost their interest in product pulse types of crops. Because the productivity rate is low (per/hectare), non-availability of good quality pulses seeds in the local market, etc. Area of very high, high, medium, low and very low productivity categories shown in the table 5.29 and its zone shows in figure 5.5. The major pulses crops are *lentil, gram, peas, maskalai* and *arhar* for yield analysis.

Table 5.29 Agricultural productivity index for pulses crops

Name of the C.D. Blocks	Productivity yield index (1990-91)	Productivity yield index (2015-16)	Growth per annum
Chopra	90.63	114.36	0.95
Islampur	72.24	102.66	1.22
Goalpokher-I	98.17	117.88	0.79
Goalpokher-II	101.23	129.30	1.12
Karandighi	88.56	145.59	2.28
Raiganj	109.32	128.20	0.76
Hemtabad	86.29	123.91	1.50
Kaliyaganj	95.84	131.14	1.41
Itahar	71.37	118.60	1.89

Source: i. District Statistical Hand Book, Uttar Dinajpur District, Bureau of Applied Economics and Statistics, Government of West Bengal, Kolkata, 2015
ii. Directorate of Agriculture, Government of West Bengal, Uttar Dinajpur
iii. Researcher's calculation.

i. Very low productivity zone

This zone (figure 5.5-A) lies in Northern and Southern part of the district with an index value ranges between 71.37 and 78.96 per cent in 1990-91. Out of a total of nine blocks, two blocks of them namely Islampur (72.24 per cent) and Itahar (71.37 per cent) lies in this zone. But in the year 2015-16, only one block namely Islampur block with an index value ranges between 102.66 and 111.25 per cent. This block having very low productivity zone with an index value (102.66) and zone lies Northern part of the district (figure 5.5-B).

ii. Low productivity zone

The area of low productivity zone with an index value ranges between 78.96 and 86.55 per cent. Low productivity pulses are confined in one block namely Hemtabad with an index value (86.29 per cent) in 1990-91 and it has increased with index value ranges 111.25 to 119.84 in the year 2015-16. Only three blocks have low productivity in pulses which are namely Chopra (114.36), Goalpokher-I (117.88) and Itahar (118.60). This zone lies in Northern, middle and Southern part of the district (figure 5.5-B). Major causes behind low productivity are acidic soil; micronutrient deficiency in the soil, the average size of landholding is <0.20 hectare. Small size land holding makes it difficult to introduce any advanced technology of farming which leads to follow old method of farming which does not yield much production.

Table 5.30 Productivity region based on yield index of pulse crops in Uttar Dinajpur District (1990-91 and 2015-16).

1990-91				2015-16			
Productivity Category	**Crop index**	**No. of C.D. Blocks**	**Name of the C.D. Blocks**	**Productivity Category**	**Crop index**	**No. of C.D. Blocks**	**Name of the C.D. Blocks**
Very Low	< 78.96	2	Islampur, Itahar	Very Low	< 111.25	1	Islampur
Low	78.96-86.55	1	Hemtabad	Low	111.25-119.84	3	Chopra, Goalpokher-I & Itahar
Medium	86.55-94.14	2	Chopra, Karandighi	Medium	119.84-128.43	2	Riganj, Hemtabad
High	94.14-101.73	3	Goalpokher-I, Goalpokher-II & Kaliaganj	High	128.43-137.02	2	Goalpokher-II, Kaliaganj
Very High	>101.73	1	Raiganj	Very High	>137.02	1	Karandighi

Source: Computed by the researcher from table 5.32

iii. Medium productivity zone

The district having medium agricultural productivity with an index value ranges between 86.55 and 94.14 per cent (table 5.30). These include the blocks of Uttar Dinajpur District are namely Chopra with an index value (90.63 per cent) and Karandighi with an index value (88.56 per

cent). This zone lies in Northern and middle-western part of the district (figure 5.5-A) in the year 1990-91. But the agricultural productivity zone index value has increased in the year 2015-16, which index value ranges between 119.43 and 128.43. This zone confined to two development blocks with an index value namely Raiganj (128.20 per cent), Hemtabad (123.91 per cent) and zone lies in South-Western part of the district (figure 5.5-B).

iv. High productivity zone

High productivity zone for pulses is confined to three blocks (figure 5.5-A) with an index value namely Goalpokher-I (98.17), Goalpokher-II (101.23) and Kaliaganj (95.84). This zone lies in the middle-western and Southern part of the district in the year 1990-91. On the other side, in the year 2015-16, it is confined to only two blocks with such an index value namely Goalpokher-II (129.30) and Kaliaganj (131.14). This zone also lies in the middle-Western and Southern part of the district (figure 5.5-B).

v. Very high productivity zone

In the district, very high productivity pulse crops are limited to only one block with an index value ranging between 102.73 to 109.32 per cent in the year 1990-91. This zone (figure 5.5-A) lies in South-Western part in the district. Only one block having very high productivity zone namely Raiganj with an index value (109.32). But in 2015-16, very high productivity index value ranges have increased between 137.02 to 145.61 per cent. Only Karandighi Block lies in this zone with an index value (145.59). This zone is located (figure 5.5-B) in the South-Western part of the district. The reasons behind the highest productivity in this block are modern development of irrigation facilities, intensive cultivation, use of HYV seeds and farmers are using a huge amount of chemical fertilizers in their crop field.

5.6.2.2.1 Growth of agricultural productivity in Uttar Dinajpur District (1990-91 to 2015-16)

The growth of very high agricultural productivity index per annum is 2.28 (table 5.31) in between 1990-91 to 2015-16 as recorded in Karandighi Block. But very low growth index per annum is in Goalpokher-I (0.79 per cent) in the district. The growth of agricultural productivity for pulses crops of Uttar Dinajpur District in between 1990-91 to 2015-16 are shown in the table 5.31. Per annum growth zone distribution is shown in figure 5.5-C.

Table 5.31 Changes in per annum productivity of pulse crops (1990-91 to 2015-16).

Productivity Category	Crop index	No. of C.D. Blocks	Name of the C.D. Blocks
Very Low	<1.07	3	Chopra, Goalpokher-I & Raiganj

Low	1.07-1.38	2	Islampur, Goalpokher-II
Medium	1.38-1.69	2	Hemtabad, Kaliaganj
High	1.69-2.00	1	Itahar
Very High	>2.00	1	Karandighi

Source: Computed by the researcher from table 5.30

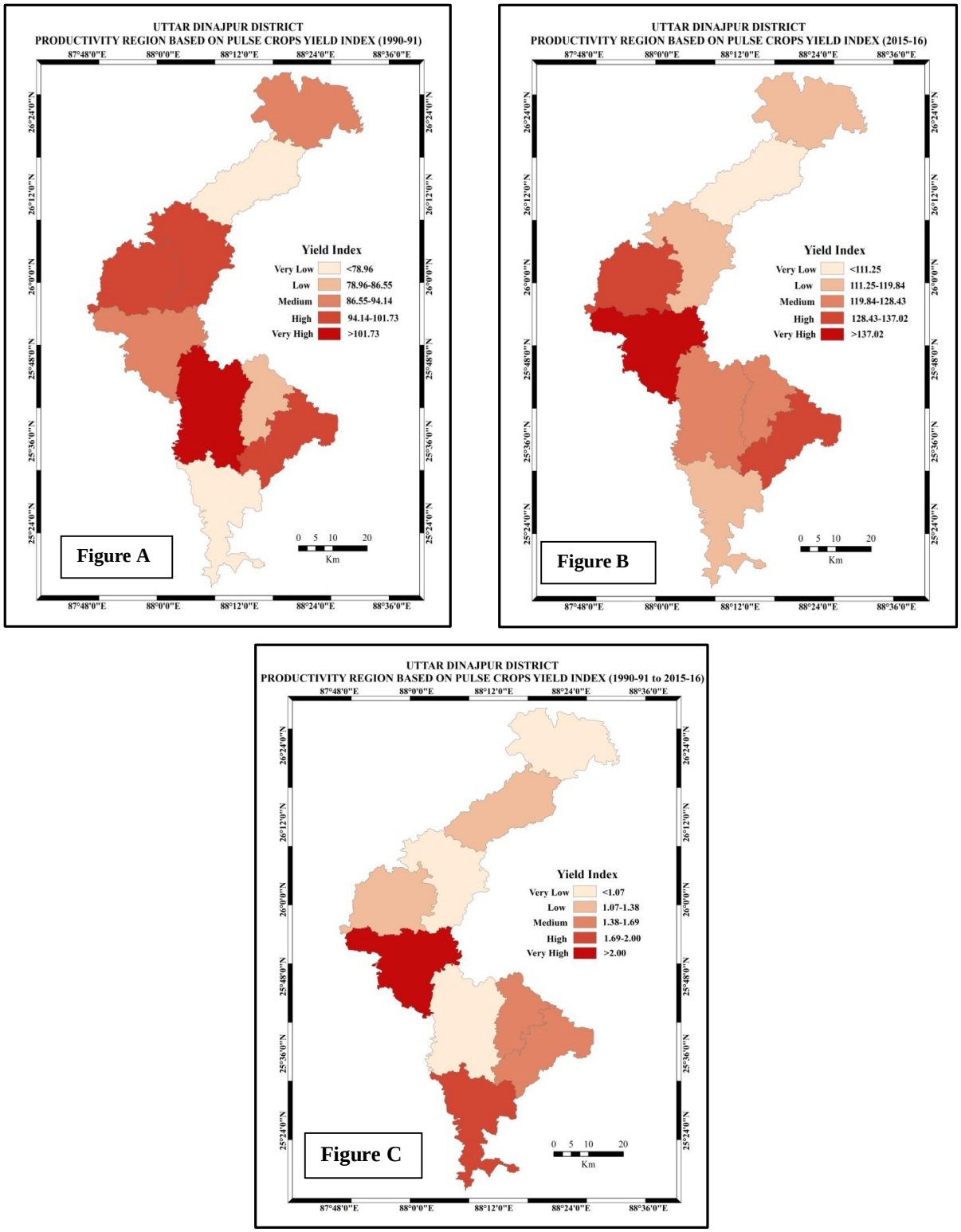
It is observed from the table 5.31 that, all blocks of the study area having higher values of agricultural productivity index have an increase except the Chopra, Goalpokher-I and Raiganj block which is shows a marginal increase in agricultural productivity. Per annum medium agricultural productivity index is confined to two blocks namely Hemtabad (1.50) and Kaliaganj (1.41). On the other side, very low and low per annum growth of productivity index confined to five blocks namely Chopra (0.95), Goalpokher-I (0.79), Raiganj (0.76), Islampur (1.22) and Goalpokher-II (1.12). Per annum growth zone distribution is shown in the figure 5.5-C. The reasons behind the very low and low productivity in Chopra, Goalpokher-I, Raiganj, Islampur and Goalpokher-II blocks is land not being suitable for pulse crops, low soil fertility, farmers being untrained for pulse cultivation, etc.

5.6.2.3 Agricultural productivity zone based on cash crops yield index

Cash crops are grown for district sale in the local or international market, rather than for family consumption. These are many cash crops produced in the study area. Among the cash crops-potato and sugarcane are considered for the analysis of cash crops productivity analysis. The productivity index value computed for cash crops is shown in the table 5.33 and figure 5.6.

i. Very low productivity zone

This zone (figure 5.6-A) lies in the middle-Western part and South-Eastern part of the district. Very low productivity cash crops are confined to two blocks with an index value ranges between 70.12 to 81.04 per cent in 1990-91. These two blocks having a very low productivity zone with an index value Karandighi (78.92) and Hemtabad (70.12). But in the year 2015-16, out of nine blocks, three blocks of them namely Chopra (128.39), Karandighi (124.92) and Hemtabad (131.12) are lying in this zone. The productivity index value in this group is below 132.48 per cent and zone lies (figure 5.6-B) Northern, middle-Western and South-Eastern part of the district.



Source: Prepared by the researcher based on crops productivity data.

Figure 5.5 Status of agricultural productivity of pluses crops (1990-91 to 2015-16).

Table 5.32 Agricultural productivity index for cash crops

Name of the C.D. Blocks	Productivity yield index (1990-91)	Productivity yield index (2015-16)	Growth per annum
Chopra	99.04	128.39	1.17

Islampur	87.48	134.20	1.87
Goalpokher-I	98.34	140.65	1.69
Goalpokher-II	90.60	136.26	1.83
Karandighi	78.92	124.92	1.84
Raiganj	101.86	154.31	2.09
Hemtabad	70.12	131.12	2.44
Kaliyaganj	113.32	162.70	1.97
Itahar	124.72	159.59	1.39

Source: i. District Statistical Hand Book, Uttar Dinajpur District, Bureau of Applied Economics and Statistics Government of West Bengal, Kolkata, 2015
ii. Directorate of Agriculture, Government of West Bengal, Uttar Dinajpur
iii. Researcher's calculation.

ii. Low productivity zone

Low productivity cash crops are confined to two development blocks with agricultural productivity index namely Islampur (87.48) and Goalpokher-II (90.60) in the year 1990-91. Low productivity is entitled to the index value ranging from 81.04 to 91.96 per cent. This zone (figure 5.6-A) lies in the Northern and middle-Western parts of the district. On the other hand, index value has increased in the year 2015-16 and it ranges between 132.48 to 140.04 per cent. Low productivity zone with an index value of two blocks namely Islampur (134.20) and Goalpokher-II (136.26). It is an interesting fact that, in 1990-91 and 2015-16, this two blocks occupying in the same group (i.e. low productivity zone) and located in the same place (zone) of the year 1990-91.

iii. Medium productivity zone

The blocks with the agricultural productivity index value range from 91.96 to 102.88 per cent are classed as having medium productivity. Medium productivity index lies in the three blocks, namely Chopra (99.04), Goalpokher-I (98.34) and Raiganj (101.86) in the year 1990-91. This zone is located in Northern, North-Western and South-Western parts of the study area. But in the year 2015-16, only one block namely Goalpokher-I (140.65) lies in this zone and productivity index value ranges between 140.04 to 147.60 per cent. This zone lies in the North-Eastern part of the district (figure 5.6-B).

Table 5.33 Productivity zone based on yield index of cash crops in Uttar Dinajpur District (1990-91 and 2015-16).

1990-91				**2015-16**			
Productivity Category	**Crop index**	**No. of C.D. Blocks**	**Name of the C.D. Blocks**	**Productivity Category**	**Crop index**	**No. of C.D. Blocks**	**Name of the C.D. Blocks**
Very Low	<81.04	2	Karandighi, Hemtabad	Very Low	<132.48	3	Chopra, Karandighi & Hemtabad
Low	81.04-91.96	2	Islampur, Goalpokher-II	Low	132.48-140.04	2	Islampur, Goalpokher-II

Medium	91.96-102.88	3	Chopra, Goalpokher-I & Raiganj	Medium	140.04-147.60	1	Goalpokher-I
High	102.88-113.80	1	Kaliaganj	High	147.60-155.16	1	Raiganj
Very High	>113.80	1	Itahar	Very High	>155.16	2	Kaliaganj, Itahar

Source: Computed by the researcher from table 5.32.

iv. High productivity zone

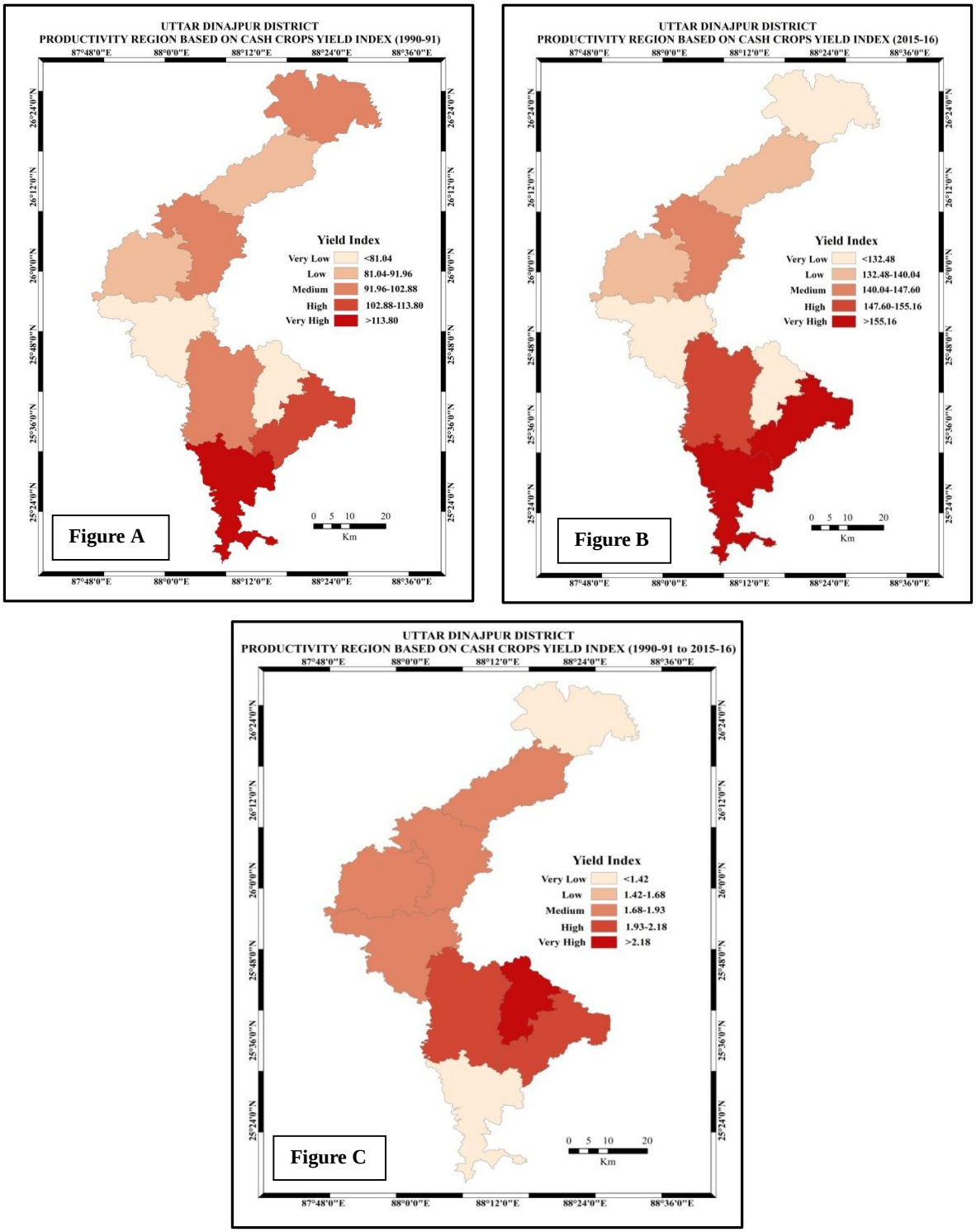
The high productivity zone has an index value ranging between 102.88 to 113.80 per cent. Only one block namely Kaliaganj has such an index value (113.32) and zone lies in South-Eastern part of the district (figure 5.6-A) in the year 1990-91. But in the year 2015-16, only one block lies in this zone. Its index value ranges between 147.60 to 155.16 per cent and Raiganj block has such an index value (154.31). This zone is located in the South-Western part of the district (figure 5.6-B). The reason behind the high productivity in this block is the use of modern seeds (HYV), availability of government sub-marshible water for smooth irrigation, use of chemical fertilizers, etc.

v. Very High productivity zone

Very high productivity cash crops is confined to only one block with an index value above 113.80 per cent in 1990-91 and it has increased above 155.16 per cent in 2015-16 (figure 5.6-A). In 1990-91, a very high productivity zone was in Itahar (124.72) and in the year 2015-26, it is Kaliaganj (162.70) and Itahar (159.59) per cent. But this zone was located in the year 1990-91 in Southern part but in 2015-16 it has changed to Southern and also South-Eastern part of the district (figure 5.6-B). Causes of very high productivity are farmers being more conscious of the production of crops, time to time water supply in the crop field and many others.

5.6.2.3.1 Per annum productivity growth of cash crops (1990-91 to 2015-16)

The growth of very high agricultural productivity index per annum is 2.44 (table 5.34) in between 1990-91 to 2015-16 as recorded in Hemtabad Block. But per annum a very low growth index observed is Chopra (1.17 per cent) in the district. The growth of agricultural productivity for the period of the study blocks in Uttar Dinajpur District in between 1990-91 to 2015-16 has been shown in the table 5.34. Per annum growth zone distribution is shown in figure 5.6-C.



Source: Prepared by the researcher based on crops productivity data.

Figure 5.6 Status of agricultural productivity of cash crops (1990-91 to 2015-16).

Table 5.34 Changes in per annum productivity of cash crops (1990-91 to 2015-16).

Productivity Category	Crop index	No. of C.D. Blocks	Name of the C.D. Blocks
Very Low	< 1.42	2	Chopra & Itahar
Low	1.42-1.68	1	Goalpokher-I

Medium	1.68-1.93	4	Islampur, Goalpokher-II, Karandighi & Kaliaganj
High	1.93-2.18	1	Raiganj
Very High	> 2.18	1	Hemtabad

Source: Computed by the researcher from table 5.31

It is observed from the table 5.34 that, all blocks of the study area having higher values of agricultural productivity index have a maximum increase except the Chopra, Itahar and Goalpokher-I Blocks which shows a marginal increase in agricultural productivity. Per annum medium agricultural productivity index is confined to four blocks namely Islampur (1.87), Goalpokher-II (1.83), Karandighi (1.84) and Kaliaganj (1.97). On the other hand, high and very high growth per annum of productivity index is confined to two blocks namely Raiganj (2.09) and Hemtabad (2.44). The reasons behind the high and very high productivity in two blocks are plane land surface, high soil fertility, soil texture clay to clay loam type, granular type soil structure, irrigation facility is available and many others which suitable for crop production.

5.6.2.4 Agricultural productivity zone based on miscellaneous crops yield index

Miscellaneous crops achieve a significant position in the district's agriculture. There is various type of miscellaneous crops produce in Uttar Dinajpur District (according to the PAO, Uttar Dinajpur). But here I want to highlight the miscellaneous crops except for the above mention crops (i.e., cereal crops, pulses and cash crops). The considered miscellaneous crops are *Turmeric, Ginger, Jute, Mustard* and *Linseeds*. These crops are holding an important role in the cultivation of the district economy. The productivity index value computed for miscellaneous crops is shown in the table 5.35 and its zone shown in figure 5.7.

i. Very low productivity zone

Very low productivity zone are designated with index values less than 77.62 per cent in the year 1990-91. Two blocks are characterized by very low productivity zone in the district. This zone is located in the Northern and North-Western side (figure 5.7-A). Very low productivity blocks with an index value namely Chopra (70.47) and Goalpokher-I (75.22). But index value has increased in the year 2015-16 and it is less than 117.92 per cent. Very low productivity zone with an index value lies in one block namely Chopra (109.88) and this zone is located in the Northern part of the district (figure 5.7-B).

Table 5.35 Agricultural productivity index for miscellaneous crops

Name of the C.D. Blocks	Productivity yield index (1990-91)	Productivity yield index (2015-16)	Growth per annum
Chopra	70.47	109.88	1.58

Islampur	106.19	143.16	1.48
Goalpokher-I	75.22	139.83	2.57
Goalpokher-II	95.56	150.08	2.18
Karandighi	81.96	125.06	1.72
Raiganj	97.13	145.63	1.54
Hemtabad	88.21	124.38	1.94
Kaliyaganj	93.34	136.49	1.73
Itahar	79.36	126.12	1.87

Source: i. District Statistical Hand Book, Uttar Dinajpur District, Bureau of Applied Economics and Statistics, Government of West Bengal, Kolkata, 2015
ii. Directorate of Agriculture, Government of West Bengal, Uttar Dinajpur
iii. Researcher's calculation.

ii. Low productivity zone

Low productivity miscellaneous crops (*Turmeric, Ginger, Jute, Mustard and Linseeds*) are confined to two development blocks with agricultural productivity index namely; Karandighi (81.96) and Itahar (79.36) in the year 1990-91. Low productivity is entitled to the index value ranging from 72.62 to 84.77 per cent. This zone lies in the middle-Western and Southern part of the district (figure 5.7-A). On the other hand, low productivity miscellaneous crop is confined in only two blocks namely Karandighi and Hemtabad Block with the agricultural productivity index 125.06 and 124.38 per cent respectively in the year 2015-16. This zone is entitled to the index value ranges from 117.55 to 125.96 per cent in 2015-16. The low productivity zones lie in the middle-Western part and Northern part of the district (figure 5.7-B).

iii. Medium productivity zone

Blocks with the agricultural productivity index value ranging between 84.77 to 91.92 per cent are classed as having a medium productivity zone. This zone index lies in Hemtabad block (88.21) in the year 1990-91 and zone is located in the North-eastern part (figure 5.7-A) in the district. In 2015-16, the index value increased and it ranges between 125.22 to 134.00 per cent. Medium productivity zone with an index value lies in one block namely Itahar (126.12). This zone lies in Northern part of the district (figure 5.7-B).

Table 5.36 Changes in productivity based on yield index of miscellaneous crops in Uttar Dinajpur District (1990-91 and 2015-16).

1990-91				**2015-16**			
Productivity Category	**Crop index**	**No. of C.D. Blocks**	**Name of C.D. the Blocks**	**Productivity Category**	**Crop index**	**No. of C.D. Blocks**	**Name of the C.D. Blocks**
Very Low	<77.62	2	Chopra, Goalpokher-I	Very Low	<117.92	1	Chopra
Low	77.62-84.77	2	Karandighi, Itahar	Low	117.92-125.96	2	Karandighi, Hemtabad
Medium	84.77-91.92	1	Hemtabad	Medium	125.96-134.00	1	Itahar
High	91.92-99.07	3	Goalpokher-II, Raiganj & Kaliaganj	High	134.00-142.04	2	Goalpokher-I, Kaliaganj

Very High	>99.07	1	Islampur	Very High	>142.04	3	Islampur, Goalpokher-II & Raiganj

Source: Computed by the researcher from table 5.35

iv. High productivity zone

The high productivity zone is a zone with an index value ranging between 91.92 to 99.07 per cent. Three Blocks are characterized by a high productivity index namely Goalpokher-I (95.56), Raiganj (97.13) and Kaliaganj (93.34) per cent during the year 1990-91. This zone lies in the Northern and middle-eastern part of the district (figure 5.7-A). On the other hand, high productivity miscellaneous crops are confined to only two blocks namely Goalpokher-I and Kaliaganj Block with an agricultural productivity index 150.08 and 136.49 per cent in the year 2015-16 respectively. This zone is entitled with the index value ranges from 132.89 to 142.04 per cent in 2015-16 and zone lies in the Northern and South-eastern part of the district (figure 5.7-B).

v. Very high productivity zone

Very high productivity zone are designated with an index value of more than 99.07 per cent in the year 1990-91. Only one block is characterized by very high productivity in the district. Very high productivity blocks with an index value namely Islampur (106.19 per cent). This zone located in the Northern part of the district (figure 5.7-A). But index value has increased in the year 2015-16 and it is reached more than 142.04 per cent. Three blocks with an index value namely Islampur (143.16), Goalpokher-II (150.08) and Raiganj (145.63) per cent. This zone lies in the Northern and South-middle parts of the district (figure 5.7-B). The cause behind very high productivity in the district is farmers are conscious of crop rotation system, availability of good agricultural inputs.

5.6.2.4.1 Growth of agricultural productivity in Uttar Dinajpur District (1990-91 to 2015-16)

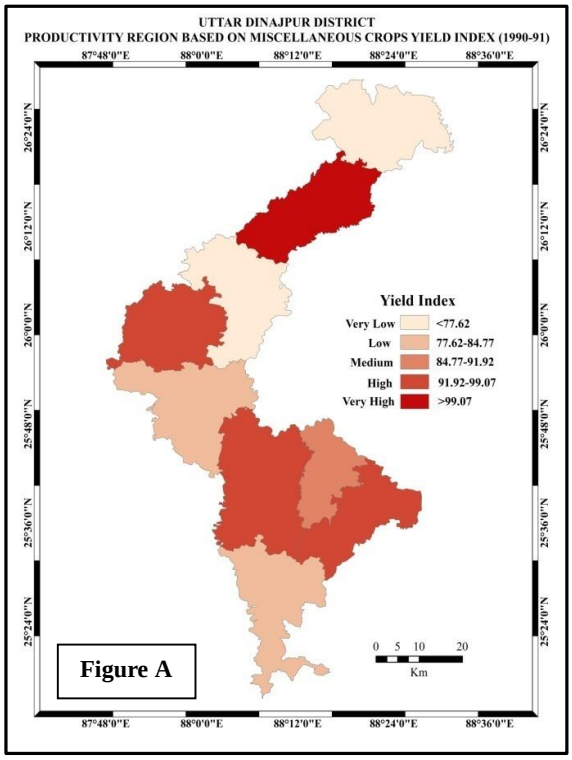
The growth of very high agricultural productivity index per annum is 2.57 (table 5.37) in between 1990-91 to 2015-16 recorded in Goalpokher-I block. But very low growth index per annum is Islampur (1.48 per cent) in the district. The growth of agricultural productivity for the period of the study blocks in Uttar Dinajpur District in between 1990-91 to 2015-16 has been shown in the table 5.37. Per annum growth zone distribution is shown in figure 5.7-C.

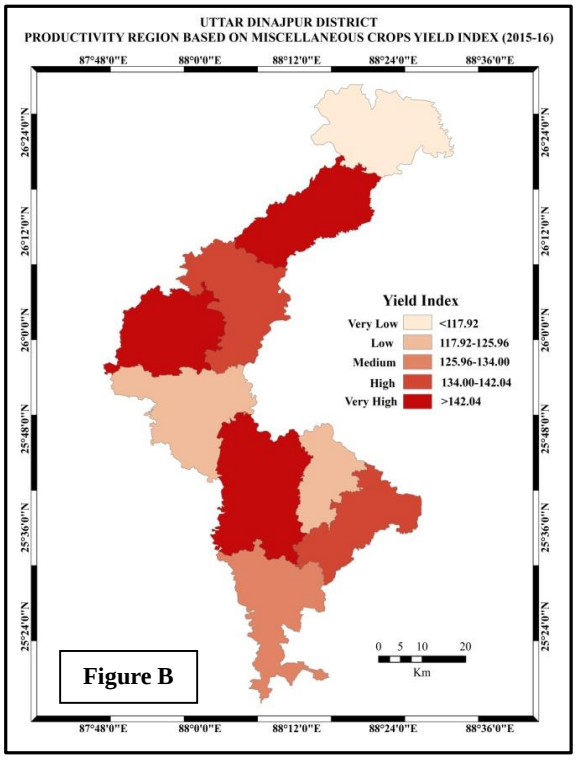
Table 5.37 Changes in per annum productivity of miscellaneous crops (1990-91 to 2015-16).

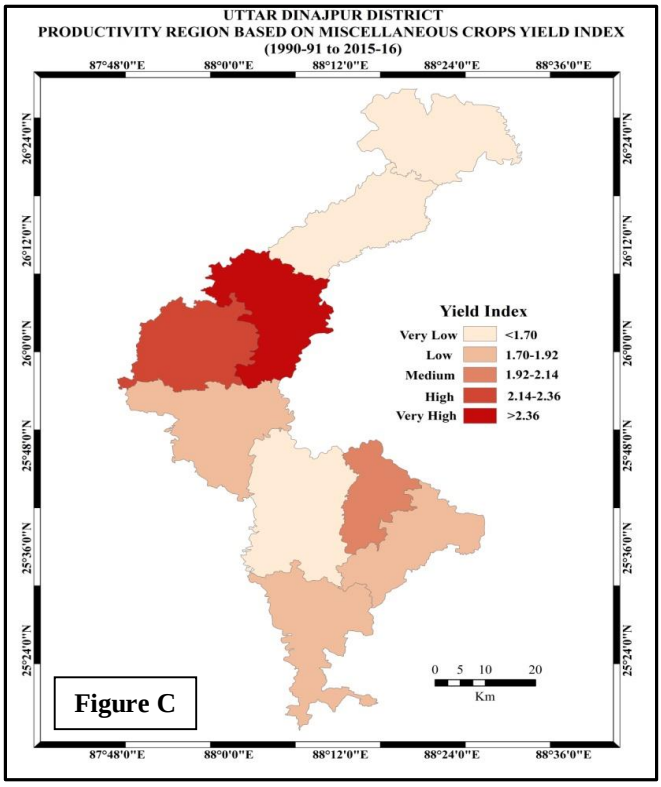
Productivity Category	Crop index	No. of C.D. Blocks	Name of the C.D. Blocks
Very Low	< 1.70	3	Chopra, Islampur & Raiganj
Low	1.70-1.92	3	Karandighi, Kaliaganj & Itahar
Medium	1.92-2.14	1	Hemtabad
High	2.14-2.36	1	Goalpokher-II
Very High	> 2.36	1	Goalpokher-I

Source: Computed by the researcher from table 5.35

It is observed from table 5.37 that, among the all blocks in the study area growth of very high agricultural productivity index per annum is 2.57 per cent in between 1990-91 to 2015-16 is recorded in Goalpokher-I. The very low growth of agricultural productivity index per annum is confined to three blocks namely Chopra (1.58), Islampur (1.48) and Raiganj (1.54) in between 1990-91 to 2015-16. Low per annum growth of productivity index confined in three blocks namely Karandighi (1.72), Kaliaganj (1.73) and Itahar (1.87). Per annum growth zone distribution for miscellaneous crops are shown in the figure 5.7-C. And high agricultural productivity index confined in one block namely Goalpokher-II (2.18). The reasons behind the very low and low productivity in Karandighi, Kaliaganj and Itahar blocks are low soil fertility (sandy and red soil), irrigation facility is poor, non-availability of high yielding variety of seeds and many others.







Source: Prepared by the researcher based on crops productivity data.

Figure 5.7 Status of agricultural productivity of miscellaneous crops (1990-91 to 2015-16).

5.7 Conclusion

From the above discussion it is clear that, the agricultural innovation and their potentiality can change the use of agricultural land. Although, these potentialities are not equally distributed in all over the district. It has been feasible due to a steady summation of economic, technical as well as political elements which jointly helped to create a dynamic and progressive environment helpful to overall agricultural development. Mechanization in agriculture depends on the farmer's choice and capacity, mechanization agents like tractor, thresher and harvester's high price and non-availability in the local market. But in resent time agricultural mechanization processes have grown in all blocks of the district by availing the governmental schemes and easy banking loaning system, HYV seeds in agriculture another potentiality for changing agricultural land use.

HYV crops mainly depend on their market efficient which greatly animates agricultural production in the district. A change in agriculture can be brought by applying modern inputs like; chemical fertilizers and pesticides which increased the production and productivity. In the district, per hectare chemical fertilizers used in agricultural fields increased day by day, i.e. from 23.82 kg in 1990-91 to 139.68 kg in 2015-16. On the other hand, an agricultural

productivity study is most important for the capacity of productivity of different crops in the district. During the study period (1990-91 to 2015-16) levels of agricultural productivity has increased in all of the blocks of Uttar Dinajpur District. Increasing agricultural productivity (all crops) in the district is a good sign for future generations as well as establishes sustainable economic development. The rapid change of mechanization, use of chemical fertilizers, pesticides and productivity in agriculture has also brought forth new areas for concern. From the beginning, solitary aim of the agricultural scientists was to increase the food production. But today it moved from food production to the problems of agricultural land use change.

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