# SPATIAL PATTERN OF LAND USE AND LEVELS OF AGRICULTURAL DEVELOPMENT IN ALIGARH DISTRICT, U.P. 

## THESIS

# SUBMITTED FOR THE AWARD OF THE DEGREE OF Tactor of 3hyilosophy 

IN

## GEOGRAPHY

## By

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This is to certify that Rejpi Sharma has completed her doctoral thesis on the title Spatial Pattern of Land Use and Levels of - Igricultural Development in .Aligarh District, U.P. under my supervision. The present research work in my opinion is fit for evaluation.
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I, RAJNI SHARMA, Department of Geography, certify that the work embodied in this Ph.D thesis is my own bonafide work carried out by me under the supervision of Prof. Shamsul Haque Siddiqui at Aligarh Muslim University, Aligarh. The matter embodied in this Ph.D thesis has not been submitted for the award of any other degree.

I declare that I have faithfully acknowledge, given credit to and referred to the research workers wherever their works have been cited in the text and the body of the thesis. I further certify that I have not willfully lifted up some other's work, para, text, data, result etc. reported in the journals, books, magazines, reports, dissertations, theses, etc. or available at websites and included them in this Ph.D thesis and cited as my own work.

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# INTRODUCIION 

## Agriculture is the foremost of all the professions -

## Poet Kumaravyasa

Agriculture is the most dominant sector of Indian economy. As per estimates by the Central Statistics Office (CSO), the agriculture and allied sector contributed about 14 percent in Gross Domestic Product (GDP) of the country during 2013-14 and provides employment to about 50 percent of work force of India. The importance of agriculture can not be denied because of its concerns for food security, employment, eradication of rural poverty, nutrition of rural masses, national security and multiplier effect on entire economy. In the words of Samuelson and Solow, if agriculture stagnates it will act as a break on industrial expansion and halt real growth.

It is clearly mentioned in the first five year plan, without a substantial increase in the production of food and raw materials for industry, it would be impossible to sustain a higher tempo of industrial development. In an underdeveloped economy with low yield in agriculture, there is no real conflict between agricultural and industrial development. One cannot go far without the other, the two are complementary. It is necessary, however, on economic and other grounds, first of all to strengthen the economy at the base and to create conditions of sufficiency and even plentitude in respect of food and raw materials.

Development of agriculture is the logical and necessary starting point for the general economic development of our country. It would lead to an increase in the purchasing power of the rural poor and will help the growth of non-agricultural sectors in order to promote economic growth. It also provides for the welfare of the farmers and their families. Thus it is agriculture which must provide greater employment, either within itself or providing capital to non-farm jobs.

Land is the basic input for agriculture and basis assets of the farmers. Land use is one of the vital aspects of development in agriculture fields, which is multi-dimensional concept rising merely not only contributes to agricultural production to feed the large and fast growing population of the country but it also provides fodder to feed the livestock population. Land utilization deals with the problems of land from one major use to
another general use. With our present methods of land use, the available is insufficient for our needs. Even though, percentage area under crops is fairly high in comparison with advanced countries of the world. Yet agricultural production is not adequate to meet needs because of low yield of the crops in comparison of the developed nations. There is no possibility of our being able to meet the existing and increasing needs unless our techniques of land utilization are greatly improved. Apart from the need of increasing production, there is also urgent need to conserve our natural resources like land, water and vegetation.

Therefore, growing the demand for food and agricultural raw materials, it is needed to solve the problem by increasing production through the intensification of land use, increasing productivity, diversified cropping system using new agricultural technology without harming the environment. Therefore, Land use research has pulled the attention of various planners and researchers in both developed and developing countries of the world because land is most precious and limited natural resources which connect with land cover, agricultural, urbanization, economic development and land use planning and others.

Kelso (1962) opined that Land utilization research can be described as dealing with problem situation in which people in a given locality are in the process of transformation from activities with certain land requirement to activities with different land requirements.

The impact of land use changes directly observed on sustainable environment. The increasing pressure on land is due to increasing population, food production, settlements, expansion of industries and infrastructural facilities. The use of extensive unbalanced fertilizers, pesticides, and extensive use of irrigation led to serious problem to the land quality. Jackson (1963) discussed that the demand for new uses of land may be inspired by a technological change, or by a change in the size, composition and requirements of a community. Some changes are short-lived, whereas others represent a more constant demand. In such way, the land is used by man for various purposes like agriculture, forest, buildings, industrial, recreational, and others. Therefore, the study of
land use change provides essential information for land use planners for its sustainable management.

Agricultural development is the interplay of physical, social, economic and technological variables. It also includes a number of aspects like agricultural land use, cropping intensity, crop productivity maintain the sustainable environment and development. It should be evaluated or assesses by the agricultural production and productivity and also by the various inputs like extent of cultivated area, irrigation, consumption level of fertilizers, high yielding varieties of seeds, labour, and degree of mechanization.

United Nations expressed views about agricultural development, our rapid and unbalanced growth of the industrial sector, may give rise to phenomena which in the long run is likely to retard economic development, balance of payments’ difficulties, inflation, excessive urbanization, and the disruption of social patterns.

Development of agriculture is difficult task in our country because of increasing pressure of population on land. The increasing population and demands for food production create regional imbalances in agricultural production due to various factors like use of fertilizers, available of irrigation facilities, agricultural instruments, adoption of High Yielding Varieties and new agricultural technology and other factors. Therefore, a proper planning is needed at micro level rather than macro level; we overcome the problems of land use and agricultural development

## Scope and Significance of the Study

Today, when we are facing crucial problem of increasing pressure of population on the limited land resources, it is essential to study the use and misuse of land, its exploitation and conservation for the welfare of the human beings, society and country. This necessitates the proper planning of the land resources, which must be preceded by a through and careful factual survey of the present position and its scientific investigation. The optimum utilization of land resources must contribute to the maximum of its capacity
and must serve some purpose useful to the society. The growth of population has changed the agricultural land into settlements, conversion of forest into cropland and others.

The scope of the present study encloses important constituent of land use related with agricultural land use, cropping intensity, crop productivity, development of agricultural and land use planning. Land use planning should emphasis on utmost utilization of land for different purposes. The every piece of land should be proper utilized; it should be checked because if agricultural land is changed into settlements, it is never returned to the farmers.

India has only 2.41 percent land area of the world but it supports over 18 percent of the world population. Therefore, there is need to enhance the agricultural development process in order to meet the challenges of increasing population. The present study has been attempted to focus on changes in use of land and problem of agricultural development at micro level. We can overcome the problems of nation by the study of micro level analysis.

The use of remote sensing and geographic information system is now powerful technique for identifying and monitoring land use changes. Remote Sensing data provides accurate information about land use to the planners in various development activities and planning of existing resources. It is closely associated with the development of agriculture.

Therefore, a scientific investigation is essential for clear picture of different aspects of agricultural development over space and time. Keeping in mind of these aspects, Aligarh district has been selected as the study area for analyzing pattern of land use and levels of development because of uneven distribution of innovative practices of agriculture. Aligarh district has recorded an increase of about 20 percent population growth during 1991-2011. The district is primarily agrarian in nature. It has about 80 percent net sown area of total geographical area. About 42 percent of the land holdings are less than 1 hectare in size and only 0.19 percent of the land holding are more than 10 hectares. It lies in the fertile plain of the Ganga and the Yamuna rivers. Therefore, it is the most important region in point of view of agriculture. In spite of good climatic
conditions, fertile soil, better irrigation, the region is facing low yield, low use of agriculture mechanization, and loss of natural resources. The study area has a lot of changes in land use pattern and agricultural development during fifteen years of study periods, i.e. 1996-97 to 2011-12. The year 1996-97 has been chosen for study because some parts of Aligarh district has gone to newly created district Mahamaya Nagar (Hathras) in 1997. The pattern of agricultural development is characterized by several distortions because of unequal distribution of agricultural facilities. The size of land holding also responsible for increasing inter regional disparities in the level of agricultural development in Aligarh district. The study of changes in land use and agricultural development at micro level would be helpful in reorienting programmes and priorities of agricultural development so as to maintain balanced agricultural development in study area. The present study emphasis on proper utilization of land and development of agriculture through increase in production and productivity and provide facilities to small and marginal farmers.

## Objectives

To make a comprehensive study, following objectives are selected

1) To assess the land use/land cover of Aligarh district through the application of RS and GIS techniques for two years i.e. 1996 and 2011.
2) To analyze the changing pattern of land use/land cover under respective categories during study periods.
3) To examine spatio-temporal changes in agricultural land use pattern, and to assess the growth in area, production, and yield of major food crops of Aligarh district.
4) To analyze the spatio-temporal pattern of agricultural productivity in district.
5) To find out the factors of agricultural development in study area.
6) To identify the level of agricultural development at two points of time i.e. 199697 and 2011-12, on the basis of agricultural parameters.
7) To work out a clear picture of the agricultural land use and agricultural development at micro level on the basis of detailed village level field survey.
8) To suggest measures for proper utilization of land and evolve effective strategies for agricultural development.

## Hypotheses

> Agricultural development is directly related to agricultural technology.
$>$ The high adoption of agricultural technology is directly proportionate to size of land holding.
> The farmers having adequate and assured irrigation are more adoptive of agricultural technology as compared to others.

## Data sources

The present study is based on secondary as well as primary sources of the data. The secondary data has been used for period of 1996-97 and 2011-12 to study at block and district level whereas primary data has been collected at the village level for the micro level study during 2016.

## Secondary sources:

> Toposheets of 1975, Survey of India on a scale of 1:50,000 have been used for delineation of the study area.
$>$ Landsat 5 imagery for land use/land cover in the year of 1996 has been downloaded from USGS/Earth explorer. This imagery was taken in date of 8 February 1996 with sensor mode SAM having WRS Path/Row 146/041
> Landsat 5 imagery for land use/land cover in the year of 2011 has been downloaded from USGS/Earth explorer. This imagery was taken in date of 1 February 2011 with sensor mode BUMPER having WRS Path/Row 146/041
$>$ Census of India, $(1991,2011)$
> Aligarh gazetteer, 2001,
> Website of Indian Metrological Department, Pune was used for taken the data of rainfall and temperature for the study area,
> Agricultural Statistics Bulletin of Aligarh District, (from 1997 to 2013), published by Directorate of Lucknow, Uttar Pradesh,
> Agriculture Statistics Office of Aligarh District,
> Block Headquarter Statistical Office of Aligarh District,
> District Census Handbook, Aligarh, 2011, Primary Census Abstract, Part XII-B,
> Village and Town Directory, Aligarh, 2011,

## Methodology

- The base map has been prepared from the Survey of India topographic sheets with the help of Arc-GIS 9.3 software assigning UTM, WGS 1984, $43^{\circ} \mathrm{N}$ zone projection systems and after that, map has been geo-referenced and rectified. The geo-referenced map was subset from the Landsat imageries from USGS/Earth Explorer with the help of Erdas Imagine 9.3 software. After it, supervised classification method was used to avoid misclassification of land use/land cover with ground verification. Land use/land cover has been classified into major seven classes i.e. built-up land, agricultural land, fallow land, tree plantation, water bodies, wet lands and sandy area according to study area based on National Remote Sensing Agency Scheme of classification. Thereafter, change matrix was run to assess the land use/land cover change during 1996 to 2011.
- Simple percentage method has been used to calculate the area of land use/land cover, cropping pattern.
- To calculate accuracy of land use/land cover map, kappa coefficient technique has been used. Kappa coefficient formula is calculated as:

$$
K=\frac{N \sum_{i=1}^{r} X_{i i}-\sum_{i=1}^{r}\left(X_{i+} \times X_{+i}\right)}{N^{2}-\sum_{i=1}^{r}\left(X_{i+} \times X_{+i}\right)}
$$

Where,
$r=$ the number of rows in the error matrix
$\mathrm{X}_{\mathrm{ii}}=$ the number of observations in row i column i (along the diagonal)
$\mathrm{X}_{\mathrm{i}+}=$ the marginal total of row i (right of the matrix)
$\mathrm{X}_{+\mathrm{i}}=$ the marginal total of column i (bottom of the matrix)
$\mathrm{N}=$ the total number of observations included in the matrix

- Growth rate has been used for calculating area, production and yield of major crops.
- To examine the trends of crop, trend lines have been plotted by regression equation $\mathrm{Y}=$ $a+b X$, it represents the exact change in area, production with the help of regression line.
- Doi's Method has been used to delineate crop-combination regions. Doi's formula can be expressed as follows:

$$
\left(\sum \mathrm{d}^{2}\right)
$$

The combination having the lowest $\left(\sum \mathrm{d}^{2}\right)$ will be the crop-combination. It is not required to calculate $\left(\sum \mathrm{d}^{2}\right)$ for each combination but the crop combination is actually established by One Sheet Table which is prepared himself by Doi.

- Cropping intensity is calculated as follows:

$$
\frac{\text { Gross Cropped Area }}{\text { Net Sown Area }} \times 100
$$

- Yang’ Crop Yield Index method has been used for measuring agricultural productivity regions of major groups of crop. Yang's crop yield index method considers yield of different crops related in a block compared with the average crop yield in the entire district.
- Karl Pearson's Coefficient of correlation has been used to calculate the strength of relationship between the variables of agricultural development with the help SPSS programme at the significance level of 1 percent and 5 percent.
- A factor analysis has been used for grouping the variables of agricultural development and explained percentage variance of total variables in agricultural development. Factor score have been used to categories the level of factors into high, medium, and low in study area.
- To determine the level of agricultural development in study area, twenty-two variables have been transformed into indices using z-score technique. The formula is

$$
\mathrm{Zi}=\frac{X i-X}{S D}
$$

Where,
$\mathrm{Zi}=$ Standard score of the ith observation,
$\mathrm{Xi}=$ Actual value of the ith observation,
$\overline{\mathrm{X}}=$ Mean of the value of X variable
SD = Standard deviation of $X$ variable

Further, the results of the standard score obtained for different indicators, were aggregated by Composite Standard Score (CSS). The Composite Standard Score is algebraically expressed as

$$
\mathrm{CSS}=\frac{\sum z i j}{N}
$$

Where,
CSS = Composite Standard Score,
Zij = Z-score of an indicator j in block i ,
$\mathrm{N}=$ Number of indicators.

- For conductive primary survey, the sampled derived for the study is based on purposive random sampling technique. A total of twenty-four villages are selected out of 12 blocks of study area. Two villages have been selected from the each block of the study area. The base for selection criteria for two villages from one block is on the basis of accessibility and size of population. Sources of irrigation and market distance have also kept in mine in selection of villages. One village has been selected along the road and other was at least 3 km away from the road. From each village, 10 percent of the total households have been selected on the random basis including all caste peoples. Therefore, 763 total households were surveyed. From each household, the senior farmer of the family who cultivates the field was selected. It has been tried to select those villages which have population between 1500-2000 persons. Finally, selected respondents have interviewed in detail with the help of structured schedule. The field survey has been conducted in Rabi season (month of February, March and April) in 2016. After completing field survey of selected villages, data were entered into SPPS then the processing of data was carried out by simple percentage method, correlation, multiple regression and z -score.
- Arc Gis 9.3, Arc View GIS version 3.2, ERDAS IMAGINE 9.2, GPS, SPSS Version 16.0 and Microsoft Office 2007 have been used to interpret the data and to draw maps and diagrams for effective cognition.


## Study Area

Aligarh district is located in the western part of Uttar Pradesh, extending between latitudes $27^{\circ} 34^{\prime} \mathrm{N}$ and $28^{\circ} 11^{\prime} \mathrm{N}$ and longitudes $77^{\circ} 29^{\prime} \mathrm{E}$ and $78^{\circ} 38^{\prime} \mathrm{E}$. The study area is spread over an area of 3648.31 square kilometers with a total population of $36,73,889$
persons (Census 2011) having 1199 villages. It is bounded by the district of Etah in the east, Mathura in the west, Bulandhshahr in the north and Hathras in the south. The extreme north eastern boundary formed by the river Ganga, separates the Budaun district from Aligarh district whereas the extreme north-western boundary, formed by the river Yamuna, divides Aligarh district from Gautambuddha Nagar district.

The maximum extent of the district is about 62 kilometers from north to south and about 116 kilometers from east to west. The shape of Aligarh district is dominated by an east-west extension. From the administrative point of view, the Aligarh district has been divided into five tehsils, namely, Khair, Ghabana, Koil, Iglas and Atrouli and these five tehsils have been further divided into twelve blocks, namely, Tappal, Khair, Chandaus, Jawan, Lodha, Dhanipur, Akrabad, Gonda, Iglas, Atrouli, Bijouli and Gangiri..

According to 2011 census, Aligarh district ranks $19^{\text {th }}$ in terms of population in Uttar Pradesh. The density of population is 1,007 persons per sq. km that is higher than the state average i.e. 829 persons per sq. km. It ranks $41^{\text {st }}$ in literacy with 67.5 percent which is lower than the state average ( 67.7 percent). The decadal growth rate of Aligarh district has 22.8 percent. There are about 23.97 percent cultivators and 22.75 percent agricultural labourers to total workers who are engaged in agriculture.

## Plan of the Work

The present study "spatial pattern of land use and level of agricultural development" has been organized into seven chapters excluding introduction and conclusion which are as follows-

Chapter first deals with the historical background of the study area. It also deals physical and cultural setting including location, structure and relief, drainage system, climate, soil, vegetation, hydrology, population distribution, growth, density, literacy, occupational structure, industries and transport network of the region.

Chapter second gives a broad description of the conceptual framework and literature review of land use, agricultural land use and agricultural development.

Chapter three discusses the pattern of land use/land cover especially built-up land, agricultural land, fallow land, tree plantation, water bodies, wet lands, and sandy area in two periods i.e. 1996 and 2011. It also examines the changes in land use/land cover and transformation of one land use categories into other categories during 19962011 with the help of remote sensing and geographic information system.

Chapter four explains cropping pattern of major crops, growth rate in area, production and yield, crop ranking, changes in crop combination and cropping intensity of the study region from 1996-97 to 2011-12.

Chapter five deals with concept and measurement of agricultural productivity and find out the level of agricultural productivity regions of cereals, pulses, oilseeds and cash crops with the help of Yang's crop yield method.

Chapter six presents the details about level of agricultural development using factor analysis and z-score by considering twenty two variables at two point of time i.e. 1996-97 and 2011-12. An attempt has also been made to correlation of agricultural productivity with other variables of agricultural development.

Chapter seven describes d micro level observations of selected twenty-four villages of the study area. It presents the general profile and location of selected villages, age and education composition of selected respondent. It also examines the size of land holdings, cropping pattern of Kharif and Rabi season, area, production and yield of major crops, use of agricultural implements by the farmers, use of irrigation sources, application of chemical fertilizers, HYV and Bio- fertilizers. It also deals the relationship between agricultural land use and agricultural development and finally examines the levels of agricultural development of selected villages using twenty variables of human resource, technology, irrigation, land holdings and finance.

The concluding chapter begins with a summary of the findings and the conclusions inferred from them. On the basis of these findings and conclusions, an attempt has also been made to present a strategy for proper utilization of land and presents a strategy for balanced and healthy agricultural planning in the study area.

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## САААРTER-1

## PHYSICAL $\mathcal{A N D}$ <br> CULTURAL SETTİNG OF $\mathcal{T H E}$ STUD Y $\mathcal{A R E A}$

### 1.1 Historical Background

There is fragmentary history about Aligarh district. Before the $12^{\text {th }}$ century, no epigraphic records are available about the antiquity of Aligarh district. The history about the naming of Aligarh is much more controversial and debatable. In earliest period, it was known as Koil which has other spelling of it like Kol, Cole etc. It assumes that people inhabited the area before the Turkish gave the name Kol. Another view is that in its earlier time, the inhabitants of Aligarh belonged to certain tribal groups which were known as koils or weavers. While Hindu myth affirms that the name of koil or kol was familiar after the name of a demon which was killed by the Balbram who was the elder brother of Lord Krishna (Singh, 1987).

## History of Ancient Period

In the view of siddiqui (1981), settlement has started in Aligarh around 1500 B.C. Another believe is that ancient culture had settled in this area around 1000 BC. The area was reigned by different dynasties like Mauryans, Sakas Kushans and Nagas by 600 BC. The remains of Buddhist period has found at Balai Qila (Upper fort). Therefore it assumes about the existence of Buddhist settlement in ancient time. Nevil (1909) view the existence of Buddhist habitation in and around the present city. The kol was reigned by the Gujjar Pratihars (Siddiqui, 1981). The remains of 465-66 AD revealed that the kol was also under the rule of Gupta and Harsh Empire. From the $10^{\text {th }}$ century AD, it identified that the Achal Tal area is one of the most ancient localities in Aligarh city.

## History of Medieval Period

There is no definite information about the Koil till the $12^{\text {th }}$ century. There has been a gap between ancient and medieval period. The Muslim invasion started from the end of the $12^{\text {th }}$ century AD. Qutubuddin Aibak captured the fortress of Koil in 1194 and Hisabuddin Ghulbak was appointed its governor (Siddiqui, 1981). Balban was a governor of mamluk dynasty who constructed the victory of Sultan Nasiruddin Mahmud and this minar stood on a high ground of Balai Qila. From the period 1194 to 1526, the Kol was under ruled by the different dynasties, dominated by Slave dynasty from 1194 to 1290,

Khilji’s from 1290 to 1320, Tughlaq's from 1320 to 1414 and Lodhi's from 1451 to 1526. In the year of 1525 , Umar Khan built the fort of Mohammadgarh which was afterword known as Aligarh.

During this period, Aligarh has emerged as an important education centre for Muslims. Ibn Batuta who was a world traveler, stayed at Koil in 1343 and he described Aligarh as a fine town in his travel record Rahila. It is surrounded by mangroves and also noticed cotton cultivation, green plantation and castor plant cultivation in its hinterland.

Throughout the early medieval period, the term khitta was used for Koil. The word khitta was commonly used for large cities at that time. The Mughal Empire has ruled from the second quarter of the $16^{\text {th }}$ century till the middle of $19^{\text {th }}$ century. The Koil was the capital of an administrative Sarkar during the period of Akbar. At that time, the Koil was divided into four dasturs and twenty one mohalla. Akbar and Jahangir, who were great warriors, came to Koil for the purpose of hunting. There was prevailing the Zamindari system during this time. In the earlier of $18^{\text {th }}$ century, jats emerges as the powerful zamidars in 1644 after the death of Empire Aurangzeb. In the earlier half of $18^{\text {th }}$ century, a tribe of Bani Israel settled in the Koil fort since the time of Behlol Lodhi who was the founder of Lodhi dynasty. In 1760, Ahmad Shah Abdali captured Ramgarh Fort and in 1775, Najaf Khan who was Mughal commander, established his rule in this area and sent his lieutenant Afrasyab who vacated Ramgarh Fort. Najaf khan renamed Ramgarh fort as Aligarh.

## History of British Period

Marathas appointed French Count De Biogne as the commander of this region. The commander made Aligarh as headquarter in 1791. Aligarh experienced peace and stability during his rule. The commander De Biogue established a cantonment outside the present Suleiman Hall of Aligarh Muslim University. Marathas sent General Cullier Perrox for taking the charge from De Biogue. General Culllier Perrox made a garden, known as Shah Bagh, located behind Aligarh Muslim University.

In the beginning of the $19^{\text {th }}$ century, this region was influenced by British. In august 1803, General Lake made Aligarh as his headquarter. In 1842, a post office was
established by Dr. Paton, Post Master General. In 1863, the first railway line was opened in the district from Tundla to Aligarh and this line has completed in 1864. Other lines were opened in the later years, i.e. Aligarh Bareilly line in 1872, Aligarh-Mathura meter gauge in 1875 and Hathras-Kasganj Line in 1884. In 1804, the Aligarh district was formed and has divided into six tehsils, namely, Koil, Atrauli, Iglas, Khair, Hathras and Sikandrarao, each with its own divisional headquarter. In 1997, the some portion of Aligarh district has undergone the newly created district Hathras (also known as Mahamayanagar). After carving out it, Aligarh has been divided into five tehsils namely, Koil, Atrouli, Iglas, Khair and Ghabana.

### 1.2 Physical Setting of Study Area

## Location

Aligarh district is located in the western part of Uttar Pradesh. It lies between latitudes $27^{\circ} 34 \mathrm{~N}$ and $28^{\circ} 11^{\prime} \mathrm{N}$ and between longitudes $77^{\circ} 29^{\prime} \mathrm{E}$ and $78^{\circ} 38^{\prime} \mathrm{E}$. The total geographical area of the district is 3648.31 square kilometers. It is bounded by the district of Etah in the east, Mathura in the west, Bulandhshahr in the north and Hathras in the south. The extreme north eastern boundary formed by the river Ganga, separates the Budaun district from Aligarh district whereas the extreme north-western boundary, formed by the river Yamuna, divides Aligarh district from Gautambuddha Nagar district. (Figure 1.1)

The maximum extent of the district is about 62 kilometers from north to south and the maximum extent is about 116 kilometers from east to west. The shape of Aligarh district is dominated by an east-west extension. From the administrative point of view, the Aligarh district has been divided into five tehsils, namely, Khair, Ghabana, Koil, Iglas and Atrouli and these five tehsils are further divided into twelve blocks namely, Tappal, Khair, Chandaus, Jawan, Lodha, Dhanipur, Akrabad, Gonda, Iglas, Atrouli, Bijouli and Gangiri which include 1170 inhabited villages.

It is situated in the fertile plain of Ganga-Yamuna Doab. According to Edward Suess, it is deep formed in the front of resistant mass of the peninsula when the Tethyan sediments were thrusted south west and compressed against them. According to the view
of M.S.Krishnan in 1956, "it is a sage in the crust formed between northward drifting Indian continent and the comparatively soft sediments accumulated in the Tethyan basin when the latter were crumpled up and lifted up into a mountain system. Sir Sydney Burrad considered it as a rift valley bounded by parallel faults on either side with a maximum down throw of 20 miles.

Table 1.1
Administrative Division of Aligarh District

| S.No. | Tehsils | S. No. | Blocks | Total <br> Villages | Uninhabited <br> Villages | Inhabited <br> Villages |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Khair | 1 | Tappal | 92 | 5 | 87 |
|  |  | 2 | Khair | 96 | 0 | 96 |
| 2 | Gabhana | 3 | Chandaus | 93 | 1 | 92 |
| 3 | Koil | 4 | Jawan | 105 | 1 | 104 |
|  |  | 5 | Lodha | 136 | 6 | 130 |
|  |  | 6 | Dhanipur | 97 | 0 | 97 |
|  |  | 7 | Akrabad | 89 | 3 | 86 |
| 4 | Iglas | 8 | Gonda | 83 | 0 | 83 |
|  |  | 9 | Iglas | 103 | 0 | 103 |
| 5 | Atrouli | 10 | Atrouli | 113 | 4 | 109 |
|  |  | 11 | Bijouli | 92 | 8 | 84 |
|  |  | 12 | Gangiri | 100 | 1 | 99 |
| Total |  |  |  | 1199 | 29 | 1170 |

Source: District Census Handbook Aligarh, 2011

## Structure and Relief

Physiographically, the district contains a vast alluvial plain which is drained by the river Ganga in the north-east and the river Yamuna in the north-west. The surface of the plain has several troughs, formed by the river valley and narrow sand ridges. The most prominent three regular lines of ridges are running from north to south. The first may be seen in between the boundary of Tappal and Chandaus block, subdivision of


Figure 1.1

Khair and Ghabhana tehsil respectively. The second ridge may be noticed along the right bank of Karwan stream and the third ridge is seen more continuous, lies up to a few kilometers in the east.

The surface level of the plain rises sharply to the high uplands flanked by the Ganga River and then descends inland gradually to a depression, drained by the Neem River, beyond which it again rises against the bank of Kali River. There is another sandy to silt belt which rises from the low and narrow khaddar belt of that stream which sinks gradually into the broad central depression. The whole district runs from north-west to south-east. This tract enters from the Ghabhana tehsil in the north and passes to the Etah district. This is very extensive low lying tract, characterized by imperfect drainage, clayey soil and numerous lakes. Further, the surface rises into a level plain which is known as western upland characterized by sandy soil. The peculiar feature of the doab forming in the north-west have loam and clay soil in the depression with shallow ground on the banks of some rivers, till finally forms a cliff of the Yamuna river from where the level falls to the Khaddar of river Yamuna.

From the perspective of topography, the district may be divided into three broad divisions which are discussed below-

1) The Khadar Plain which is found mainly along the river Ganga in the east and along the river Yamuna in the west
2) The eastern and western uplands
3) The central low lying tracts

The Central Ground Water Board Lucknow (1978) has reported that the real thickness of the alluvial deposits at Aligarh is 379.5 meters. However, a report of hydrological department of Uttar Pradesh (1984) has indicated that the depth of alluvium extends down to 286.89 meters comprising of sand, silt and clay.

The elevation of the ground surface differs from one area to another area within district. It is measured as 195 m above sea level at Chandaus and Tappal block lying in the north-west while it is 189.58 m at Somna in and around the centre of study area. The elevation of land is also estimated about 193.24 m above sea level in extreme north-east


Figure 1.2
where the Upper Ganga Canal enters from the north in boundary of Aligarh and it is measured as 176.96 m at that place where the Upper Ganga Canal leaves the district. It is measured as 186.84 m at Atrouli.

## Drainage System

There are two types of rivers, found in Aligarh district.

1) Perennial Rivers (the Ganga, the Yamuna,)
2) Seasonal Rivers (the Kali, the Isan, the Karwan, the Sengar and the Rhind)

The rivers and watersheds of these rivers are depicted in the figure 1.3 and 1.4.

## Perennial rivers

The perennial rivers are those rivers that flow continuously throughout the whole year. The Ganga, the Yamuna and the kali are perennial rivers, flow in the study area.

## The Ganga

The Ganga is the largest and most sacred river of India. It determines the economic and cultural life of the people. The Ganga originates from Gaumukh in the Gangotri glacier (known as Bhagirathi at its origin place) and enters the plain area in Haridwar and known as name Ganga here. It takes southerly direction from here and enters in Aligarh district after crossing the Bulandshahr district. It makes the north-east boundary of district and separates the Aligarh district from Budaun district. This river brings new alluvium and deposited on either sides of its banks. The volume and velocity of the Ganga River are considerably increased during rainy season.

## The Yamuna

The Yamuna is one of the most important tributaries of the Ganga. It originates from the Yamunotri glacier in Himalaya at an altitude of 3311 meters from mean sea level. It flows along the north-western border of Aligarh district coming from the north side after passing Delhi. After flowing in Aligarh district, it takes southerly direction and flow into the districts of Mathura and Agra. It also carries alluvial soil and deposits the material


Figure 1.3
Source: National Resource Information System (NRIS), Shrishti (GIS-UP)


Figure 1.4
Source: National Resource Information System (NRIS), Shrishti (GIS-UP)
along its banks. The bank of it rises gradually with a gentle slope, known as Khadar. During the rainy season, it causes floods because of its low water carrying capacity.

## Seasonal Rivers

The seasonal rivers are those rivers that receive water from the rainfall and become dry all year around. It totally depends on rainfall. There are some seasonal rivers that are found mostly in central depression of the study area. They are the Kali, the Neem, the Isan, the Karwan, the Sengar and the Rind. Therefore it experienced the poor drainage, combined with the formation of lakes and wetlands comes to the surface through capillary action and causes the formation of white layer of soil (known as reh or kallar), which leads to leakage of salt and makes the soil unfertile.

## The Kali

The Kali River is also tributary of the Ganga. It rises in the district of Muzaffarnagar and enters into Aligarh district from northern side after passing the districts of Meerut, Ghaziabad and Bulandshahr. It forms the western and southern boundary of Atrouli tehsil and separates the Atrouli tehsil from the Koil tehsil. It passes into the district of Etah near the village of Barhari. Although it has not significance throughout the year, it becomes important in rainy season when it leaves some deposits of alluvial silt during this season.

## The Neem River

It is a small stream and joins the Kali River from north on its left bank. It overflows during the rainy season and its bed has been deepened to improve drainage and using for irrigation purpose.

## The Karwan River

It is also known as karon and the water source of the Karwan is natural. It flows in a north-south direction and passes through the Khair and Iglas tehsil. After flowing across Aligarh district, it meets the Yamuna River near the Agra city.

## The Sengar River

The original name of sengar is Basind and it originates near "Adhwan" lake to the south of Panaithi. The name of river is known as Sengar after the name of Sengar Rajputs. It is the tributary of the Yamuna River and flows in a north-south direction up to the Etah district. The Sengar has low volume of water and it is not more useful for irrigation purpose.

## The Rind River

It rises from the depression near Nanua village in Akrabad block of Aligarh district. It is a tributary of the Yamuna River. After flowing in Aligarh district, it enters into Etah district. It is not so good for irrigation purpose but sometimes it provides a good yield for grains with little irrigation.

## Climate

Climate is an important unit of the physical environment which influences human life and cultural behavior in any geographical region. There are various element of climate like temperature, rainfall, pressure, wind etc. but temperature and precipitation of climate play a significant role in agriculture. Aligarh district experiences monsoon with humid sub-tropical climate. The climatic condition of Aligarh may be divided into four distinct seasons:

1) Cold weather season (December to February
2) Hot weather season (March to mid June)
3) Monsoon season (mid June to mid September)
4) Season of retreating monsoon (October to November)

## 1) The Cold Weather Season

This season starts with the end of November when the south-west monsoon completely ends. During this season, the temperature falls and pressure rises. As a result, the district comes under the influence of high pressure belt. During this season, Indian Ocean experiences low pressure while the northern plain encounters high pressure due to high and low temperature respectively. As a result of it, the wind blow from the northern plain of India towards sea. The winds are light and dry, blow at an average speed of about

Table 1.2
Rainfall and Temperature in Aligarh District

| Months | Rainfall in mm <br> (2012) | Average High <br> Temperature <br> ${ }^{\circ} \mathbf{C ~ ( 2 0 1 0 ) ~}$ | Average Low <br> Temperature <br> ${ }^{\circ} \mathbf{C}(\mathbf{2 0 1 0})$ |
| :---: | :---: | :---: | :---: |
| Jan | 21.5 | 20.6 | 7.4 |
| Feb | 0 | 23.6 | 9.5 |
| March | 0 | 30 | 14.1 |
| April | 3.2 | 36.8 | 20.1 |
| May | 0.6 | 40.1 | 24.5 |
| June | 9.5 | 39.3 | 26.6 |
| July | 138.3 | 34.6 | 26 |
| Aug | 229.4 | 33.2 | 25.4 |
| Sep | 86.1 | 33.8 | 23.8 |
| Oct | 4.5 | 33 | 18.8 |
| Nov | 0 | 28.3 | 12.9 |
| Dec | 3.5 | 22.5 | 8.5 |

Source: India Metrological Department, New Delhi/ www.imd.gov.in
2.3 kms per hour in Aligarh district. The mean monthly temperature has recorded $12.9^{\circ} \mathrm{C}$ in November and $10.5^{\circ} \mathrm{C}$ in December and $8.5^{\circ} \mathrm{C}$ in January. The diurnal range of temperature is high because of relatively cooling nights and warm days during winter season. Sometimes, the rainfall occurs in winter season due to western disturbances. The average rainfall has recorded as 3.5 mm in December, 0 mm in January, and 0 mm in February in 2012. The region is affected by hailstorms which destroy the crop production.

## 2) The Hot Weather Season

By the end of month March, this season starts and continues till the mid June. It is characterized by rising temperature and falling pressure. The maximum and minimum temperature in the month of March has been recorded as $30^{\circ} \mathrm{C}$ and $14.1^{\circ} \mathrm{C}$ respectively while the maximum and minimum temperature for the April may have been recorded as $36.8^{\circ} \mathrm{C}$ and $20.1^{\circ} \mathrm{C}$. The mean maximum temperature reaches up to $45^{\circ} \mathrm{C}$ in the month of June. In this season, the dry winds blow at a greater speed, locally known as loo. The average velocity of wind is considered about 5.5 kms per hour in district.

It is harmful for human life. In summer season, the occurrence of dry dusty winds and thunder storms are regular phenomena. It usually occurs afternoons accompanied by squall winds, light showers, heavy dust and thunder. This region receives a little amount of rainfall. In 2012, the average rainfall has been recorded in March, April, May and June by $0 \mathrm{~mm}, 3.2 \mathrm{~mm}, 0.6 \mathrm{~mm}$, and 9.5 mm respectively. The low rainfall and unfavorable conditions is not suitable for agriculture.


Figure 1.5


Figure 1.6

## 3) The Monsoon Season

This season begins in the last week of June or the first week of July with the onset of monsoon and it continues till the end of September or by the beginning of October with the retreating monsoon. The humid winds blow from Indian Ocean to this region, causing the rainfall in the district. The total rainfall receives about 70-90 percent during this season. A peculiar characteristic of rain in this season is that it does not continuous raining. There is a break of ten days or a week after continuous raining two or three days. This area received about 138.3 mm in July and 229.4 mm rainfall in the year of 2012. The mean monthly temperature falls from $40^{\circ} \mathrm{C}$ in June to $31^{\circ} \mathrm{C}$ in July in 2010. This monsoon season has special value for Indian agriculture because about 70 percent Indian agriculture depends upon the monsoon.

## 4) The Season of Retreating Monsoon

The season of retreating monsoon is characterized by clear skies, low humidity and hot weather conditions when the south-west monsoon retreats gradually by the middle half of the September. This phase continues by the end of the month of November when the whole area comes under the influence of north east-monsoon. In the month of September 2010, the maximum and minimum temperatures are recorded as $33^{\circ} \mathrm{C}$ and $24^{\circ} \mathrm{C}$ respectively. The diurnal range in these days is high due to high temperature during day hours and low temperature during the nights.

## Soils

Soils of Aligarh district is alluvial in nature and is divided into three broad subdivisions: alfisols, entisols and inteptisols (Figure 1.7). The alfisols are the older alluvial soil which is represented by the level plain above the flood level of the main rivers and their tributaries while the entisols or newer alluvium is confined to the flood plains of the rivers. The total alluvium brought by the river Ganga covers three-fourth area of the district whereas the alluvium brought by the river Yamuna spreads over one fourth area of the district.


Figure 1.7
Source: National Resource Information System (NRIS), Shrishti (GIS-UP)

The alfisoils and entisoils differ in their texture ranging from sandy to heavy clay and loams. The sandy soil is found along the both sides of river Ganga and Yamuna. The colour of the soil varies from light gray to ash gray and texture is sandy to silty loam. The soils are alkaline in reaction and saline in nature, pH being usually above 8 . These soils can be used for the cultivation of alkali resistant or semi resistant crops such as sugarcane, barley etc. the sandy loam soil covers a sizable portion of the district. The colour of it is brown and reddish and the water holding capacity is low. These soils are deficient in organic matter and plant nutrients. The loamy soils is found between the khaddar lands of the rive Ganga and river Kali. This type of soil is very fertile and its colour varies from light brown to dark brown. The soils are neutral to mild acidic in reaction. The common crops of the area having loamy soil are wheat, maize, millet, pea and arhar. The drainage in the clayey loam soil is bad and these soils suffer from water logging. Its colour is gray, ash gray or dark gray tending to become black when moist on sandy elevated land. The bad drainage results in the deposition of soluble sodium salts on the surface.

## Vegetation

The deciduous type of vegetation due to humid sub-tropical climate is found in the district. The forest is continuous decreasing due to pressure of growing population on land. The forest is converted either in agricultural lands or in built-up lands. There is considerable extent jhau forest in the khadar plain of the river Ganga. The most common trees are Babul, Neem, Mango, Sheesham, Jamun etc. found in the study area.

## Hydrology

The ground water exits in the pore spaces of unconsolidated alluvial material in the zone of saturation. The study of National Hydrograph Stations and State Government Wells reveals that the depth of water before monsoon ranges between 2.06 and 21 meters. The shallow water condition is found ranging between 5-10 meters and occurs along the Upper Ganga Canal in the Jawan and Akrabad block and along the main branch canal in the part of Tappal and Gonda block. It has been observed the deepest water level more than 15 meters in the central part of the district. The water level of rest fall the range

Table 1.3
Water Table Heterogeneity in Aligarh District, 2007

| S.No. | Well Name | Pre-monsoon <br> (mbgl) | Post-monsoon <br> (mbgl) | Fluctuation <br> (m) |
| :---: | :---: | :---: | :---: | :---: |
| 1 | Andla | 11.26 | 4.45 | 6.81 |
| 2 | Bhikampur | 12.83 | 12.15 | 0.68 |
| 3 | Gonda | 3.6 | 2.51 | 1.09 |
| 4 | Gopi | 6.85 | 6.07 | 0.78 |
| 5 | Gorai | 7.51 | - | - |
| 6 | Hardauaganj | 3.31 | 2.18 | 1.13 |
| 7 | Jawan | 2.06 | 1.96 | 0.1 |
| 8 | Khair | 7.98 | 7.88 | 0.1 |
| 9 | Palachand | 5.21 | 5.17 | 0.04 |
| 10 | Safedpur | 6.08 | 4.87 | 1.21 |
| 11 | Sankra | 4.9 | 4.8 | 0.1 |
| 12 | Sudiyal | 10.45 | 9.67 | 0.78 |
| 13 | Taquipur | 2.5 | 2.9 | -0.4 |
| 14 | Bagichi | 10.72 | 9.83 | 0.89 |
| 15 | Iglas | 6.25 | 6.23 | 0.02 |

Source: Based on data obtained from Central Ground Water Board Report (2008)
between 10-15 mbgl. During the post-monsoon period, the water level generally ranges between 1.96 and 17 meters. The shallow water level occurs less than 5 meters, found in the eastern and western part along the Ganga and Yamuna rivers and its tributaries.

The shallowest water level has observed about 1.96 mbgl in Jawan block. The study of CGWB during the period 1998-2007 reveals that the annual rise has been observed only by 15.4 percent and annual decline has been observed by 84.6 percent. It seems that the water level is continually declining due to excessive use of water for domestic, industrial, agricultural purposes. The two blocks (Atrouli and Khair) of district fall under the critical condition of water level.

### 1.3 Socio-Cultural Setting of Study Area

After studying the history and physical background of study area, it is necessary to see the role of socio-cultural aspects in changing the land use pattern and agricultural development. Jasbir Singh and Dhillon (1987) is of view that the necessity of the evolution of socio-economic variables in terms of input involved in agriculture sector that have been ultimately forming land use pattern and yield per hectare. In this section, it is highlighted about the population dynamics (distribution. growth rate, density, and literacy), occupational structure, industries, transportation, marketing facilities and land holding.

## Distribution of population

The population is an important human resource in determining the land use pattern and agricultural development. The total population of the district is 367, 3889 persons out of this the rural population contributes 66.87 percent and urban population share only 33.13 percent. There are 19,51,996 male and 17,21,893 female population out of which rural male and female share 67.06 percent and 66.66 percent to the total male and female population respectively. Table 1.4 indicates that the maximum population has been recorded in Gangiri block having 269975 persons whereas the lowest population has been reported in Akrabad block with 79951 persons.


Figure 1.8

Table 1.4
Block-wise Distribution of Population in Aligarh District, (2011)

| Blocks | Area | Total <br> Population | Male <br> Population | Female <br> Population | Rank of <br> Population <br> Size | Rank <br> of <br> Area |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Tappal | 319.47 | 194252 | 103570 | 90682 | 6 | 1 |
| Khair | 289.73 | 189350 | 100790 | 88560 | 8 | 3 |
| Chandaus | 279.68 | 186726 | 99621 | 87105 | 9 | 4 |
| Jawan | 231.82 | 204891 | 108576 | 96315 | 4 | 8 |
| Lodha | 217.31 | 264567 | 140740 | 123827 | 2 | 10 |
| Dhanipur | 233.27 | 200445 | 106734 | 93711 | 5 | 7 |
| Akrabad | 211.88 | 171056 | 91105 | 79951 | 12 | 11 |
| Gonda | 252.21 | 186341 | 99875 | 86466 | 10 | 5 |
| Iglas | 220.15 | 192628 | 103013 | 89615 | 7 | 9 |
| Atrouli | 246.73 | 210787 | 111620 | 99167 | 3 | 6 |
| Bijouli | 190.43 | 185680 | 99583 | 86097 | 11 | 12 |
| Gangiri | 293.02 | 269975 | 143696 | 126279 | 1 | 2 |
| Total | 2985.7 | 2456698 | 1308923 | 1147775 |  |  |

Source: Based on Census of India (2011)


Figure 1.9

## Growth of Population

The study area has been the cradle of human civilization because of the fertile plain besides the water availability from the Ganga and Yamuna Rivers. The growth rate of population of Aligarh district has been recorded by 22.78 during 2001-11. The blockwise growth rates are depicted in table 1.5 and figure 1.10. It shows that the Lodha block has recorded highest population growth rate by 31.86 percent and 25.31 percent during both decades while Jawan block has received lowest growth rate by -3.07 during 2001-11 and Atrouli has recorded lowest growth rate by 10.09 percent during 1991-2001

Table 1.5
Block-wise Growth rate in Aligarh district (1991-2011)

|  | Census Year |  |  | Growth Rate |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Blocks | $\mathbf{1 9 9 1}$ | $\mathbf{2 0 0 1}$ | $\mathbf{2 0 1 1}$ | $\mathbf{1 9 9 1 - 0 1}$ | $\mathbf{2 0 0 1 - 1 1}$ |
| Tappal | 155646 | 169705 | 194252 | 9.03 | 14.46 |
| Khair | 144360 | 166015 | 189350 | 15.00 | 14.06 |
| Chandaus | 148406 | 174333 | 186726 | 17.47 | 7.11 |
| Jawan | 176187 | 211390 | 204891 | 19.98 | -3.07 |
| Lodha | 160114 | 200642 | 264567 | 25.31 | 31.86 |
| Dhanipur | 144371 | 175008 | 200445 | 21.22 | 14.53 |
| Akrabad | 122466 | 145040 | 171056 | 18.40 | 17.94 |
| Gonda | 138455 | 166915 | 186341 | 20.55 | 11.64 |
| Iglas | 127126 | 155032 | 192628 | 21.95 | 24.25 |
| Atrouli | 164313 | 180899 | 210787 | 10.09 | 16.52 |
| Bijouli | 132593 | 155285 | 185680 | 17.11 | 19.57 |
| Gangiri | 16257 | 227328 | 269975 | 12.98 | 18.76 |
| Total District | 2449597 | 2992286 | 3673889 | 22.15 | 22.78 |

Source: Based on Statistical Bulletin and Census Hand Book of Aligarh District (19912011)


Figure 1.10

## Density of Population

The density of population indicates the pressure of population on land. It is calculated as ratio of total population to total area. As per 2011 census, the density of Aligarh district is 1007 person per sq. km while it was 820 persons per sq. km in 2001. It means that the pressure of population has increased on land. Due to growing pressure of population on land, the people clear the forest; convert the agriculture land into built-up land. It is seen from the figure 1.11 that the highest density has been recorded in Lodha block as 923 in 2001 and 1217 in 2011 whereas the lowest density has been recorded in the Tappal block 531 in 2001 and 608 in 2011. It seems that the Lodha block has recorded highest due to more urban facilities.


Figure 1.11

Table 1.6

## Block-wise Density of Population in Aligarh district (2001 and 2011)

(Figures in persons per sq. km)

| Blocks | $\mathbf{2 0 0 1}$ | $\mathbf{2 0 1 1}$ |
| :---: | :---: | :---: |
| Tappal | 531 | 608 |
| Khair | 573 | 654 |
| Chandaus | 623 | 668 |
| Jawan | 912 | 884 |
| Lodha | 923 | 1217 |
| Dhanipur | 750 | 859 |
| Akrabad | 685 | 807 |
| Gonda | 662 | 739 |
| Iglas | 704 | 875 |
| Atrouli | 733 | 854 |
| Bijouli | 815 | 975 |
| Gangiri | 776 | 921 |
| Total District | 820 | 1007 |
| Source: Casus 001 | 2011 |  |

Source: Census 2001 and 2011

## Literacy

Census has defined the literacy as the percentage of literates to the total population of age 7 years and above. It is an important aspect of life of human beings. The literate persons adopt new technology and new methods for increasing crop production easily. The literacy rate of Aligarh district is 69.60 percent in 2011 as compared to 58.48 percent in 2001. The literacy rates of male and female are 80.24 percent and 57.47 percent respectively in 2011. The block-wise literacy rate are shown in table 1.7 it shows that the highest literacy rate are in Chandaus block by 62.28 in 2001 and 72.14 in 2011 percent while the lowest literacy rate is in Bijouli block by 43.31 in 2001and 57.35 percent in 2011.

Table 1.7
Block-wise Literacy Percentage in Aligarh District (2001 and 2011)

| Blocks | Male |  | Female |  | Total |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathbf{2 0 0 1}$ | $\mathbf{2 0 1 1}$ | $\mathbf{2 0 0 1}$ | $\mathbf{2 0 1 1}$ | $\mathbf{2 0 0 1}$ | $\mathbf{2 0 1 1}$ |
| Tappal | 76.50 | 82.53 | 39.97 | 52.88 | 59.57 | 68.67 |
| Khair | 77.50 | 85.23 | 41.00 | 56.67 | 60.60 | 71.86 |
| Chandaus | 77.52 | 84.85 | 44.36 | 57.64 | 62.28 | 72.14 |
| Jawan | 74.88 | 83.38 | 42.03 | 57.3 | 59.64 | 71.11 |
| Lodha | 74.58 | 79.48 | 43.62 | 55.42 | 60.41 | 68.22 |
| Dhanipur | 70.70 | 79.75 | 39.70 | 54.94 | 56.42 | 68.16 |
| Akrabad | 72.31 | 78.51 | 39.60 | 52.58 | 57.30 | 66.38 |
| Gonda | 79.61 | 85.04 | 39.79 | 55.83 | 61.53 | 71.47 |
| Iglas | 76.79 | 84.03 | 40.03 | 55.82 | 60.05 | 70.87 |
| Atrouli | 72.95 | 81.69 | 36.34 | 52.03 | 56.05 | 67.74 |
| Bijouli | 58.36 | 69.67 | 25.03 | 42.33 | 43.31 | 57.19 |
| Gangiri | 57.88 | 70.34 | 26.05 | 42.53 | 43.32 | 57.35 |
| Total District | 71.71 | 80.24 | 43.03 | 57.47 | 58.48 | 69.60 |
| Source: Cass | of Ina | $2001,2011)$ |  |  |  |  |

Source: Census of India $(2001,2011)$


Figure 1.12

## Occupational Structure

Generally, the occupation structure has been classified into four categories-

1) Cultivators,
2) Agricultural labourers,
3) Workers engaged in household industries
4) Others.

There are 577849 total workers in 2011 as compared to 506725 total workers in 2001 out of which cultivators occupy 49.30 percent in 2001 and 40.92 percent in 2011. The proportion of agricultural labourers has increased from 17.59 percent in 2001 to 23.55 percent in 2011. There is negligible difference in the workers engaged in household industry during the period 2001-2011. The proportion of other workers has slight increased from 28.42 percent in 2001 to 30.82 percent in 2011. The spatial distributions of the workers vary from block to block. It can be seen from the table 1.8 that the highest proportion of cultivators are found in Gangiri block 60.87 and 54.09 in 2001 and 2011 respectively. While the lowest share of cultivators accounted in Jawan, Lodha, Dhanipur block of Koil tehsil in both the year of 2001 and 2011. These blocks cover the Aligarh city. The highest percentages of agricultural labourers are found in Atrouli block by 27.21 percent in 2001 and in Akrabad by 29.62 percent in 2011 whereas the lowest percentage of agricultural labourers occupy in Lodha block in 2001 as well as 2011. In 2001, the workers engaged in household industry shows that they share highest percentage in Iglas block by 7.11 and lowest in Chandaus by 3.32 percent while in 2011 they occupy highest percentage in Chandaus block i.e. 6.86 percent and lowest in Tappal i.e. 2.24. The Chandaus block has doubled increased in workers engaged in household industry. The other workers are highest in Lodha by 50 percent and 54.92 percent in 2001 and 2011 respectively. On the other hand the lowest proportions of other workers are found in Bijouli by 16.13 percent and in Gangiri by 17.68 percent in 2001 and 2011 respectively.

Table 1.8
Block wise distribution of Occupational Structure in Aligarh district (2001-2011)

| Blocks | Total Workers |  | Cultivators |  | Agricultural <br> Labourers |  | Household <br> Industries <br> Workers |  | Others |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |

Source: Based on data obtained from District Statistical Handbook $(2002,2014)$


Figure 1.13

Table 1.9
Block-wise Distribution of Industries and Employed Persons in Aligarh district (2001, 2011)

| Blocks | Registered Industries |  |  |  | Small Industries |  |  |  | Khadi Industries |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | No. of units |  | Employed persons |  | No. of units |  | Employed persons |  | No. of units |  | Employed persons |  |
|  | 2001 | 2011 | 2001 | 2011 | 2001 | 2011 | 2001 | 2011 | 2001 | 2011 | 2001 | 2011 |
| Tappal | 0 | 0 | 0 | 0 | 132 | 9 | 543 | 22 | 1 | 0 | 14 | 0 |
| Khair | 1 | 4 | 25 | 95 | 154 | 79 | 642 | 274 | 0 | 2 | 0 | 12 |
| Chandaus | 0 | 0 | 0 | 0 | 128 | 36 | 390 | 85 | 1 | 0 | 22 | 0 |
| Jawa | 2 | 6 | 32 | 362 | 104 | 4 | 232 | 20 | 1 | 1 | 6 | 8 |
| Lodha | 3 | 6 | 45 | 170 | 120 | 15 | 601 | 45 | 3 | 18 | 52 | 240 |
| Dhanipur | 2 | 10 | 38 | 171 | 87 | 120 | 383 | 773 | 4 | 5 | 47 | 75 |
| Akrabad | 0 | 1 | 0 | 145 | 87 | 12 | 382 | 50 | 0 | 3 | 0 | 3 |
| Gonda | 0 | 3 | 0 | 270 | 124 | 8 | 467 | 24 | 0 | 1 | 0 | 8 |
| Iglas | 1 | 7 | 18 | 966 | 158 | 22 | 368 | 92 | 1 | 4 | 30 | 85 |
| Atrouli | 1 | 4 | 20 | 310 | 358 | 21 | 1632 | 86 | 0 | 4 | 0 | 85 |
| Bijouli | 0 | 0 | 0 | 0 | 60 | 4 | 163 | 12 | 0 | 2 | 0 | 35 |
| Gangiri | 0 | 0 | 0 | 0 | 137 | 5 | 484 | 10 | 8 | 1 | 57 | 16 |
| Total | 10 | 41 | 178 | 2489 | 1649 | 335 | 6287 | 1493 | 19 | 41 | 228 | 567 |

Source: District Statistical Handbook, Aligarh $(2002,2012)$


Figure 1.14
Source: National Resource Information System (NRIS), Shrishti (GIS-UP)

## Industries

There are a number of industries like cotton, glass, pottery etc. which have developed during the Mughals period. Now other industries are also spreading in different parts of the district. The lock and metal industries of Aligarh district are famous industries. There are also other industries relating to sugarcane, fertilizers, textiles, paper mills etc. developed in study area. The industries are divided into three categories registered industries, small scale industries and cottage industries or khadi udhyog industries.

There are only 41 registered industries in rural areas in this district. The small scale industries are those industries which have total investment of not more than 3 crores. It depends upon local raw material. It diminishes the agricultural raw material. It may be clearly seen from the table 1.9 that the small scale industries are down from 1649 to 335 during 2001-2011. The cottage industries are organized at household level under the management of private sources or by the family members. These types of industries are handloom and handicrafts. The total cottage industries are 41 in Aligarh district in which 567 persons employed in the district in the year of 2011. The block-wise distribution of industries can be seen from the table 1.9.

## Transportation

It is of prime importance for agricultural development. It is a chain between rural area and urban area. The basic structures of transport facilities also influence the land use pattern. The famous Grand Truck Road passes through Aligarh. Recently, it is modified as highways. There is new built expressway, known as Yamuna Expressway (6 lane Expressway) crossing at Tappal block. The NH-93 road pass Aligarh district and connects Moradabad to Agra. The total length roads are 3251 kilometers.

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## CHAPTER-2

## CONCEPTUAL FRASMEWORK $\mathcal{A} \mathcal{N D D}$ LITERATURE REVIEW

This chapter deals with the concept of land, land use, classification of land use and land use changes especially in the use of agricultural land. It includes literature review of land use and agricultural development at all levels.

### 2.1 Conceptual Framework

Land is the sole natural resource of the economy and development of a country. It supports all primary activities with also secondary and tertiary sectors. It meets the demands and needs of whole terrestrial ecosystem. Geographically land has been regarded as "a specific area of the earth's surface, its characteristics embrace all reasonably stable, or predictably cyclic attributes of the biosphere, to the extent that these attributes exert a significant influence on present uses of land by man" (Brinkman and Smith, 1973).

Campbell et al., (1993) state land as "first and foremost denotes space. The qualities of land include, in addition, such attributes as the topographical, structural, agricultural and mineral properties of the site, the climate, the availability of clean air and water and finally a host of immediate environmental characteristics such as quiet, privacy, aesthetic appearance and so on."

A complete definition of land used in the documentation for the contention to combat desertification by Food and Agricultural Organization (FAO) of United Nations 1994, "Land is detectable area Land is a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology, the near-surface sedimentary layers and associated ground water reserves, the plant and animal population, the human settlement pattern and physical results of past and present human activity."

The Food and Agricultural Organization (FAO) (1995) states the definition of land to be "a physical entity in terms of its topography and spatial nature; this is often associated with an economic value, expressed in price per hectare at ownership transfer."

Land is a finite and non-renewable resource of nature for any country; it cannot be extended to higher desirable level. Land is crucial for all developmental activities including natural resources, ecosystem services and agriculture (Nibanupudi and Shaw 2014).

Land use is a dynamic concept. It is changing with space and time due to advancement of technology and other factors. The term land use refers to use of land surface to serve human needs. It is the actually use of any parcel of land for residential, agricultural, industrial, retail and service activities, tree crops, pastures and other purposes.

Land use is the basic concept of agricultural economy. It is an important to understand the geographical adjustment of agricultural resources. In addition, land use patterns are dependent on a large number of geographical expressions of social decision which is different at different times for different reasons. The variation in the land use depend on the different distribution of physical factors (temperature, rainfall, topography, drainage and soil characteristics of the region), several human and economic factors. It is the bundle of different social values and certain institutional controls, which create different patterns of land use within the limitation imposed by different agro-physical controls. The increase population is a major factor which is responsible for the major shift of land use pattern. Land use is determined by the cooperation of two set of factors, one is physical factors including geology, relief features, climate, soils and vegetation which limit the potential use of land and other one is cultural factors comprised economic and industrial features (Mandal, R.B. 1982).

The easy understanding of land use is that the actual and specific use of land surface which is put to in terms of inherent primary land use i.e. built up land, cultivation, forest, fallow, vacant etc. there are a lot of geographers that define land use in following way:

Carl O. Sauer (1919) defined the term 'land use' as "the use to which the entire land surface is put". Land use is that group of associated human activities by which the land is made to yield products of value to man (Clawson and Stewart, 1965). Land use
means surface utilization of all developed and vacant land for a specific point at a given time and space (Freeman T.W. 1968). Land use is any kind of permanent or cyclic human intervention on the environment to satisfy human needs and the land uses capability or land suitability is the potential capability of given tract and to support different types of land utilization under given cultural and socio-economic condition (Vink, 1975).

Young has mentioned that the land use at any given place and time 'results from decisions based on the interaction of five groups of factors: environmental, technological, economic, social and political’ (Young, 1975). Man is the active agent who determines the use of land according to his wishes (Jasbir Singh 1974). The nature of human is to gain maximize profit from available resources using his perception and capability. There are tri-elements i.e. accessibility, facility and mobility that controlled the uses of land and other factors like method of farming, use of machine, change in technology and growing labour determined the nature and character of land use (Singh, 1992).

Campbell (1987) defines land use as "use of land by humans, usually with emphasis on the functional role of land in economic activities". According to Lillesand and Kiefer (1987), "the term land us relates to the human activities associated with the specific piece of land, factures present on the earth surface." And in the words of NRCS (1992), "It is the purpose of human activity on the land". Land use pattern of a region is combined result of physical, economic and social factors.

Jolly and Torrey (1993) explained land use as "varying activities executed by humans to exploit the landscape". Skole (1994) states that "Land use itself is the human employment of a land-cover type, the means by which human activity appropriates the results of Net Primary Production (NPP) as determined by a complex of socio-economic factors".

Food and Agricultural Organization (1995) described land use as "the function or purposes for which the land is used by the local human population and can be defined as the human activities which are directly related to land, making use of its resources or having an impact on them". Food and Agricultural Organization/United Nations Environment Programme (1999) defined land use during the course of development of
the Land Cover Classification System: "Land use is characterized by the arrangements, activities, inputs people undertake in a certain land cover type to produce, change or maintain it".

Zubair (2006) described land use as "intended employment of land management strategy placed on the land cover by human agents, or land managers to exploit land cover".

Sometimes, we find overuse and misuse of land so planning should be frame a guide in such a way that land resources attain maximum utilization with their conservation for future generation.

The both term land use and land cover are related to each other and are not mutually exclusive, land use can be estimated on the basis of land cover and relevant evidences (Campbell, 1972). Land cover indicates, "The vegetation and artificial constructions covering the land surfaces" (Burley, 1961). Land use is the human employment of a land cover (Skole, 1994). Like the land use, land cover can not be defined based on human activity. The changes in land use and land cover affects to each other. Moreover, it is not necessarily that the land use change land cover. Land cover refers to the natural vegetative cover and types of it of a specific area. They are reflection of the local climate and landforms, though they can be altered. Meyer (1995) defines land use as "the way in which and the purposes for which, human beings employ the land and its resources: for example, farming, mining, or lumbering" and described land cover as "the physical state of the land surface: as in cropland, mountains or forests". It deals with the quantity and type of surface vegetation, water and earth materials (Meyer and Turner, 1994).

Land use/land cover is the basic requirement for utilization of resources. It is also essential for conservation and management because land use planning and management strategies hold keys for the development of any region (Anon, 1992). Besides, land use and land cover change has been recognized as an important driver of environmental change, on all spatial and temporal scales (Turmer et. al., 1994). To understand the land use/land cover change of area, it is needed what changes occur, where and why they
occur, the rates at which they occur and what factors are responsible for those changes (Lambin et al., 1997).

There are two major categories of land use changes: Conversion and Modification. Conversion denotes the changes of one land use category to another land use category, for example- conversion of agricultural land into built-up land. On the other hand, modification refers to maintenance and changes in attributes of broad land use/land cover, for example transformation of natural forests to plantation. The purpose of modification in land use is to change in land cover with its intensity and management (Verburg, 2000). The classification of land use/land cover has no ideal condition. The users made classification of land use according to their needs.

The knowledge about changes in land use/land cover is essential for a modern nation. Therefore, a nation has overcome haphazard and uncontrolled development, loss of fertile agricultural lands, and destruction of forests. Land use change refers shift or different use or an intensification of the existing ones of any particular region. Land use data are essential for understand the present scenario of an area. Change detection is a process of identifying differences of an object at different times. With the help of change detection, one can observe changes of one land use to another land use categories.

In the studies of land use, remote sensing is an accurate and faster method of collecting and updating the information of land use/land cover. The remotely sensed data are helpful in quantifying the spatial and temporal effects of datasets. The remote sensing technology is easier to detect the changes in land cover over a period of time at a lower cost with better accuracy in less time (Kachhwala, 1985). Geographic Information System (GIS) techniques describe relationship between data and making an estimate. It is helpful in making suitable alternatives for efficient management of large and complex databases.

### 2.2 Review of Literature

The work on land use, agricultural land use and agricultural development has been done by various geographers, researchers in different parts of the world.

## World Land Use Studies

Carl O Sour (1919) was suggested the idea of map showing the land use. The history of land use was explored in Great Britain. Baker (1923) published his famous article entitled with "Land Utilization in United States: Geographical aspect of the problem". The regional survey of land use and its mapping was carried out by Patrick Geddes. But during 1930’s based on own contribution, L.D.Stamp (1930) has made a systematic and comprehensive survey of use of every parcel of land in Britain. The results of the survey gave an assessment of the factors responsible for the complex pattern of land use and classification of land use. The mapping of England, Wales and Scotland was instigated by Stamp in 92 parts with the help of specialist volunteers using the ordinance survey. "At the time the entire country was covered by a map series at 1:10,560 (six inches to a mile). Each sheet represented six square miles, and depicted field boundaries, buildings and other cultural details" (Campbell, 1987). With an update on changes in first land utilization survey, L.D.Stamp (1962) published the finding of the survey in a voluminous book "The Land Use of Britain: Its Use and Misuse."

In his monumental study of 'Land Utilization in China', J.L.Buck (1937) conducted a survey of 22 provinces of China. He studied land utilization, food and population problems, standard of living of the people, marketing and price level. He has made no attempt to record the use of land on maps. Roland (1947) emphasized the land resources as a matter of economic significance and the people adjust land on the basis of price benefit. In such a way, land use is result of the interplay of supply and demand.

After his pioneer work, the International Geographical Union (IGU) in Lisbon has appointed a commission to study the World Land Use Survey in 1949 under the chairmanship of Valkenburg S. Van. The Italian National Research made the land utilization map of Italy in the 1950's. The eighteen conference of the IGU organized at Rio-de Janerio (1956) made a land use survey in all parts of the World under the chairmanship of Stamp. R.R.Rawson and K.R Sealy (1956) prepared the land utilization map of Cyprus on a scale 1:2,500, 00. Arthur Hillman (1957) put the concept of land use planning. A. Coleman (1960) organized the Second Land Use Survey of Britain on the

1:25,000 and recorded seventy categories, some of it was relevant in drawing maps of land use studies and some larger categories were useful in data analysis only.
J. Kostrowicki (1968) developed a new pattern of land utilization based on agricultural typology, agricultural regionalization and planning or programming agricultural development in the Department of Geography, Poland. J.R. Anderson (1969) discussed the problems of as how to use land resources and how much production comes from various uses of land in the World Atlas of Agriculture. He evaluated the effect of various factors such as environment, socio-economic condition and historical on land use. Whyte, R.O. (1976) designed principles and techniques for land appraisal, relevant for all developing countries of the world

Uyanga, J. (1978) conducted a study on "land use, productivity and population change in South Australia: 1961-1971" using Cobb-Douglas production function for correlation productivity and population. He found that there is a high-correlation between low labour productivity and areas with farm out-migrants.
D.G. Brown et al. (2000) linked socio-economic change with changes in forest cover in upper Midwest, USA. They described Markov Transition Matrix for relationship between forest and non-forest area over a ten year period. The study shows that agricultural land is decreased while forest area is experienced increase growth. Jenerette, G.D. and $\mathrm{Wu}, \mathrm{J} .(2001)$ analysed the land use pattern from 1912-1995 in Arizonaphoenix region, U.S.A. the result revealed that urban area is correlated with the increase in population.

Najafi (2003) described the land utilization system and agricultural productivity in Asia. He found that land degradation indicated to reduce total factor productivity and crop yield. Chemical degradation was significant degradation which was degraded 40 percent of agricultural land. He also found that the pressure of population and land tenure system had resulted in the degradation of natural resources.

Rasul and et al. (2004) found out the factors in Chittagong hill tracts of Bangladesh which influenced the land use system using factor and discriminate analyses.

The study concluded that institutional support, productive resource base and distance to the market and service centre were the main factors responsible for three types of land use systems i.e. intensity of use, degree of diversification and commercialisation.

Ningal, T et al. (2007) carried out the work on relationship between land use change and population growth during the year of 1975 and 2000. The study concluded that rapid growth of population is responsible for decreasing area in agriculture.

Rahman (2009) evaluated environmental impacts of Chasma Right Bank Canal (CRBC) on land use, irrigation pattern, production, mechanization, fertilizers, water table and to find out the changes in cropping pattern and cropping intensity in Dera Ismail Khan District, Pakistan. The study concluded that cultivated land increased particularly in the command area while there is no significant impact on cultivated land outside the command area. He found out that positive changes are occurred in wheat, pulses and rice and the cropping intensity is also increased after the advent of CRBC.

Lawal, A.F. et al. (2009/2010) tried to assess the land use pattern, crop diversification and sustainability of food crop production in the fadama southern guinea savanna of Nigeria. The study concludes that Niger state is sustainable in terms of food crop production.

## Using Remote Sensing

Turner discussed LUCC in the field of "land change sciences" within four broad topic areas: "observation and monitoring; understanding the coupled system- causes, impacts, consequences, modeling and synthesis issues".

Dimyati (1995), Adeniyi and Omojola (1999) analysed land use and land cover changes in Indonesia and Nigeria. Yukio Himiyama (2001) studied the trend and achievements of land use/land cover in Japan. He suggested themes and direction for future planning. Geist (2002) explained the local level activities which are directly responsible for forest cover change.

Mohamed Ait BELAID (2003) analysed urban rural land use change detection using RS and GIS technologies. He concluded that agricultural land is decreasing due to increase settlement, urbanization and decreasing water table.

Agyepong and Sosthenes (2003) analysed the spatial pattern of land use/land cover and socio-economic causes for changing the land use/land cover in Ghana. They examined mainly crop land sand fallow lands. They observed that the active crop cultivation was recorded about 54.4 percent area of the country whereas the fallow land was covered about 30-40 percent area. The crop yield has recorded low in spite of using chemical fertilizers and new varieties of crops.

Lambin et al. (2006) argued in their book on "Land Use and Land Cover Change: Local Processes and Global Impacts" that researchers are approaching an "overarching theory" of LUCC "that explain change in the behavior of the people as well as land cover/use change".

Vanwambeke, S.O. et al. (2007) analysed land use change and rural transformation using household survey and satellite data. They found a great diversity in agriculture and by using industrially produced inputs and marketing networks increase in the proportion of new cash crops.

In the book of Jha and Singh, various geographers like Singh, Gautam, Joshi, Jain, Jha, Sharma, Madhvi (2008) etc. focused on dynamics of land use in different parts of the world. They concerned the changes of land use with suitable remedial steps for check it with new technologies.

Reis, S. (2008) analysed the changes in land use/land cover in Rize of Turkey using Landsat data for the year of 1976 and 2000. It was experienced that changes in land use/land cover were occurred in coastal areas. The result also indicated that agriculture and urban area was increased while pastures and forestry land was experience negative growth.

Carr et al. (2009) studied agricultural land use in Latin America. He noticed that population growth and urbanization promote agricultural intensification. Commercial
agriculture at large scale is solution that can trump the effects of population growth on agricultural land use.

Tomas Ayal et al. (2009) studied land use/land cover changes in Madison County, Alabama using Landsat images. They used supervised and unsupervised classification to assess the impact of land use/land cover on environment. The result revealed that the urban residents and industrial area experience increase due to demand for industries whereas agriculture, pastures, water and wet lands recorded decrease in area due to increasing demand for real state land.

Zhou, Q. et al. (2011) attempted to investigate human impacts on an arid environment over a last 30 year period. They used image classification and vegetation index to investigate categorical change and quantitative change respectively. The result revealed that the study area was changed 40 percent by natural resources and 18 percent by human-induced related to change of irrigation works. Hansen et al. (2013) presents the high resolution global map of forest change for the year 2000-2012 with the help of Landsat 7 imagery.

Tilahun and Teferie (2015) inspected the accuracy assessment of land use/land cover classification in the case of Kilite Awulalo, Tigray State of Ethiopia for the year of 2014 using Landsat 8 OLI_TIRS image. They used supervised classification of land use with the help of Arc GIS and Google Earth and the result revealed that overall accuracy and kappa accuracy is 82.00 \% and 77.02 \% that is acceptable.

## Indian Land Use Studies

The Indian Geographers have also tried to apply quantitative techniques in the analysis of land use components and agriculture.
S.P. Chatterjee (1945) conducted land utilization survey in 24 Parganas of West Bengal. He discussed the impact of soil and climate on land utilization, population pressure on land, trade and transport, nature of land utilization and agricultural implements.

Shafi (1951) has carried out the land utilization survey on the basis of systematic sampling method. He carried out the sample study of twelve villages in eastern Uttar Pradesh. V.L.S. Prakash Rao (1956) adopted the techniques of the soil survey in the Godavari region. He emphasized on sampling technique for field survey in such a large country. Shafi (1960) focused extensive field survey in eastern Uttar Pradesh and made actual land use maps at micro level. He has classified the village fields into three categories i.e. good quality land, medium quality land and last poor quality land according to their fertility and productivity.

Mishra S. (1964) attempted the work on "Land use in Khadar and Ravines of Lower Middle Gomati Valley.' He attempted land use planning for better adjustment of agriculture to the physical environment for optimum exploitation and conservation of natural resources. Chauhan (1966) divided the land into different categories according to a single factor or a particular interpretation.

Gosal et al. (1967) have paid special attention on the land use and agricultural land use change in Punjab with reference to socio-economic variables such as irrigation sources and size of land holding. Mukherjee (1967) observed the changing land use pattern in Howrah district and suggested planning strategies for agricultural land use Siddiqui and Ahmad (1967) have studied the crop land use in the Luni basin wherein they identified crop combinations and scheme of regional classification.

Roy (1968) presented the classification of land use and discussed the outline of land use condition in the arid zone of Rajasthan. In his paper 'Land Reforms and Land Use in Uttar Pradesh’ submitted to the IGU Symposium, Mehdi Raza (1968) described that the pressure of population on agricultural land has increased. The result is that the decline in per capita cultivated land becomes a source of the impoverishment of the masses. He stated that the pattern of land utilization depends upon physical, economic, institutional and legal factors.
K. Z. Amani (1968) has studied on 'Land Utilization in Village Golgarhi' of Aligarh district to find out the changes in land use and crop production for the period of forty years (1926-1966). During this period, a change in land use is seen only at places
where some fundamental alteration has taken place on account of the natural or human factors. Roy, B.K. (1968) worked on rural land use in Middle Ganga valley with special reference to Azamgarh district. He has tried to focus certain aspects of changing land use, lapses in land use during the five year plans, effect of population and other concomitant aspects in relation to land in the district of Azamgarh with intensive field work.

Shafi (1969) measured the land resources in terms of 'food production efficiency per unit area' and its conversion into calories. He points out that if land is used properly it can feed as many as five times the India’s Population.

Hussain (1971) determined the quality and character of the land use and agricultural activities in the Upper Ganga-Yamuna Doab. He studied the effects of physical conditions on the type of land use and the distribution of rainfall determines the agricultural activities. In his study of spatial organization of cropping patterns in four villages of North India, Blakie (1971) modified Thunen's model and highlighted that the intensity of cropping decreases as from the settlement site as increase of distance.

Siddiqui, N.A. (1971) attempted to classify the land according to their native characteristics, pre-existing use, yield capacity. Amani (1976) attempted to study and interpret the existing and changing pattern of land use in four villages of Aligarh district. On the basis of land use and population figures, an attempt has also been made to calculate per head per day calorie intake of the village population.

In his study "Land utilization and Agricultural situation in Bikaner" Malhotra, S.P. (1976) concluded that size of land holding, cropping pattern, cultivation and land use play a significant role in the agricultural development..

Pal and Shukla (1981) have analysed changing pattern of agricultural land use in Chittaurgarh district of Rajasthan at micro level. They have taken changes in land use during 1954-74 and also worked out land use combination regions. They have applied the Shafi's S.N.U. and Jasbir's technique in order to assess the productivity and carrying capacity of land in terms of population.

Mandal, R.B. et al. (1982) explained the physical as well as cultural factors which determined the extent to which the land can be utilized. He further explained that mapping of every piece of land is essential for future better use of land. Sen (1986) emphasized the change in land use pattern in Uttar Pradesh and also discussed how the land use pattern disturbed the ecosystem of the existing area.

Kaur, D. (1991) discussed the changing patterns of land use in the Bist Doab from 1951 to 1980. He analysed that distance from the market; village settlement and irrigation are the major factors affecting agricultural land use.

Chand and Joshi (1992) analysed the changes in land use and in area, production and yield of major crops during 1965-66 to 1985-86 in Western Uttar Pradesh. They also determined the impact of technological inputs on production level. The study concludes that agricultural productivity has improved due to technological inputs whereas production has fluctuated due to environmental factors.

Noor Mohammad (1992) has studied the pattern of land use in Ghaghara-Rapti Doab. He suggested points for improvement in all five major categories of land use. The study remarked that the region is equipped with potential agricultural land, but its utilization is not proper and maintained.

Bhattacharya (1992) has described the changes in land use of Bihar. He explained that lack of medium and minor irrigation facilities are responsible for decrease in net sown area and also indicated repressive agricultural infrastructure are responsible for declining intensive system of agriculture. Lahiri (1992) concluded that physical, economical and political factors are responsible for changing land use pattern at macro and micro levels.

Sundaram and Shanthi (1995) studied land utilization type in Thandalam and Thevaram village of Tamilnadu. They analysed that the nature and intensity of land use is determined by the interactions of physical and socio-economic factors.

Gopalkrishnan, K.S. et al. (1996) studied soil physiography relationship in Kodayar river basin in Kaniyakumari district. They came to conclusion that the study of
soil is necessary for land use planning. Lalwani Geeta (1996) studied the different level of contradiction in land use pattern between rapid technological changes in urban growth and slow process of planning in allocation of land use.

Singh and Vashist (1997) studied the dynamics of land use pattern in Bihar, Punjab and at all India level during the period 1950-51 to 1990-91. They examined that the area under non-agriculture use, the area under fallow land and barren and agricultural land has increased in Bihar from 1960-61 whereas it was stagnant in Punjab after 196061. The increase in non-agricultural use land led to fall in net sown area in Bihar whereas decrease in fallow land caused to rise in net sown area and higher agricultural production in Punjab.

Vaidya B.C. (1997) has given a detailed account of spatial and temporal changes in agricultural land use pattern in Yashoda basin in Wardha district. Jha, M. (1999) has conducted a study of population growth and its impact on land use in part of western Doon Valley. He concluded that population growth and farming activities are main affecting factors which change in land use/land cover.

Kolar (2000) described the effect of increasing population on land. He suggested that maximum utilization of land is the best possible way to fulfill the basic needs of the people so each type of the land category should be classified. So it may well known that how much of land is being utilized and how much of land is not utilized for cultivation. Mishra, B.N. and Mishra, P. (2001) explained the positive correlation between pedagogical structure and agricultural land use pattern in Handia tehsil of Allahabad.

Abrol, Y.P. et al. (2001) analysed the factors i.e. spread of HYV, expansion of irrigated areas, use of fertlisers and plant protection chemicals, strengthen of marketing infrastructure and introduction of subsidies which has increased food grain production (especially in rice and wheat) in Indo-Gangetic plains over the last three to four decades.

Jaikumar and Arokisamy (2003) attempted to analysis the change in land use/land cover in Eastern Ghats of Tamilnadu. They noticed that scrub land covered a major
portion of the area. They suggested that conversion of cropland into scrubland should be prevented and wasteland should convert into agricultural land for improving economy.

Mahajan, S. and Panwar, P. (2005) studied land use in context of agriculture, forest, and waste land in Ashwani Khad Watershed during 1979-1999 using data of Landsat. It was observed that during span of twenty years, agricultural land is increased due to irrigation facilities while forest and wasteland has decreased.

Chhaukar and Mittal (2007) attempted to study changing pattern of crop land use in Dadri tehsil of Haryana during the period of 1966-93. The study concluded that systematic cropping pattern enhanced on the development of irrigation facilities and use of modern agricultural technology and trends of agricultural development move towards for commercialisation of agriculture.

Singh, G. et al. (2007) revealed the land use pattern in Punjab during 2007-08. The study revealed that the overall land use pattern shows that forest land, barren land, non-agricultural land, cultivable waste land, fallow land and net sown area have 5.94 percent, 0.58 percent, 9.51 percent, 0.20 percent, 0.84 percent and 82.93 percent of the total reporting area respectively. It is found that due to announcing of green revolution technology, progressive and awakened farmers, developed infrastructure are responsible for high proportion of net sown area and low proportion of other categories of land use. H.N. Mishra et al. (2007) discussed the land use changes and food crop productivity in India.

Ahmad, M. and Siddiqui, S.H. (2010) analysed the level of agricultural land use and agricultural population in different blocks of Sant Kabir Nagar district. They have taken eight variables to measure agricultural land use with the help of Z-score and location quotient statistical technique. The result shows that the blocks having high levels of agricultural land use and share and low share of agricultural population are due to mechanization of agriculture.

Siddiqui, S.H. et al. (2010) worked on changing land use pattern and cropping intensity in Dadri block of Uttar Pradesh. They showed that location is the major factor
for determining the optimum land utilization in an area and the land use intensity is higher in those villages which are either located near the towns or on the transportation routes.

Singh, S. and Chauhan, V.S. (2010) studied the land use in Meerut district of Uttar Pradesh. He used multivariate correlation analysis to study the combined effect of sixteen significant factors of land use belonging to physical, agricultural and population groups. Out of these sixteen variables, six factors i.e. variables of irrigation, gross cultivated area, wheat area, maize area, total block area and water table bring highest influence upon the land use of the district Meerut. The aim of study is to find intercorrelation among the factors tracing their individual force.

Siddiqui, S.H. et al. (2013) analysed the marginal changes in land use of west Bengal during 2001-2011. They used simple percentage method for changes and analysed positive changes in non-agricultural, current fallow, pastures and grazing land whereas negative changes were recorded in forest, barren and uncultivated land, miscellaneous trees and groves, cultivable waste land, other fallow land and net sown are.

## Using Remote Sensing

Kundalia and Chennaih (1978) studied the spatial analysis of land use cover in Idukki district of Kerala. They classified land use categories by intensive ground truth.

Seelan et al. (1983) have analysed land utilization pattern in parts of southern Uttar Pradesh. They described the relationship between landform and land use and adopted methodology for deriving information from the landsat data.

Uchida (1997) analysed the agricultural land use in the semi arid tropics of India. She used IRS data for finding the results and found that the cropped area has changed at a wide level during 1990-1996 and the forest or bush area has also converted into cropped area. She also studied the relationship between land use change and land suitability and examined that in rabi season, the cropped area has doubled due to higher land suitability.

Chaudhary and Sinha (2003) carried out study of land use/land cover evolution in southern part of Haryana for the year of 1972-73 using topographic sheet of this year and 1996-97 using IRS 1B LISS-II data. They interpreted eight classes of land use and found out that settlements have increased whereas cropped area has decreased and create ecological imbalance in study area.

Pandy and Nathawat (2006) attempted to study on land use/land cover mapping of Panchkula, Ambala and Yamunanagar district of Haryana state in India. They observed that land use/land cover pattern of areas of these districts are controlled by agro-climatic conditions, ground water potential and other factors.

Mishra and Singh (2007) carried out study on the pattern of land use/land cover of Varanasi district during 2007 using IRS P6 LISS III satellite data. In this study, they used two statistical accuracy assessment techniques i.e. Error Matrix (EM) and Kappa Analysis ( $\mathrm{K}_{\text {hat }}$ ) for accuracy of each category. They have identified six different land use/land cover types -agricultural land, waste land, fallow land, settlement, vegetation and Waterbodies. The result shows that the overall accuracy derived from the stratified random sampling method is 83 percent with an overall accuracy with kappa statistics of 78 percent that indicated a good classification performance.

Roy and Giriraj (2008) studied land use/land cover analysis in context of India. With the onset of economic revolution in early 1990's, the changes in land use/land cover involve a series of complex interaction between biophysical and socioeconomic variables.

Yadav and Mishra (2009) identified different land use/land cover change of Mirzapur district, U.P. using IRS 1B LISS-I for 1993 and IRS-P6 LISS-III data for 2004 at scale 1:250,000. The study concluded that forest land is decreased while agricultural land has been increased due to expansion of agricultural practices on wastelands.

Prakasam (2010) observed a change in land use/land cover classification in Kodaikanal taluk of Tamilnadu state during 1969-2008 with the help of SOI taluk map of 1969, and Landsat imageries of May 2003 and April 2008. The study revealed that forest
area has decreased and built-up land, agricultural land and harvested land has recorded increase during this period.

Singh, S.K. (2010) analysed monitoring land use and land cover change between 1972-1990 and 1990-2005 in Shiwalik hills of Punjab using post classification comparison method. The study remarks that increase in population is a major factor for rapid change in land use and land cover. It is suggested that use of remotely sensed data provides useful information to resource managers and supports them in conserving and managing natural resources.

Singh, N.J. et al. (2010) studied cropping pattern and cropping intensity in Uttar Pradesh using data from IRS-P6 (AWiFS). They delineate twelve different cropping patterns and found that rice-wheat, sugarcane and rice-pulses were the major cropping pattern in U.P. the study also shows high cropping intensity in study area calculated by Multiple Cropping Index and Cultivated Land Utilization Index.

Anil, N.C. et al. (2011) attempted to study the changes in land use and land cover of southern part West Godavari district through Survey of India toposheet, Landsat imagery and IRS-1D-LISS-III. The aquaculture and agriculture have been decreased whereas settlements, fallow lands and plantation mixed with crops showed increase during 2000-2010.

Nagarajan and Poongithai (2011) identified the changes in land use/land cover of rural agricultural watershed of Tamilnadu using merged data from IRS LISS III and PAN. They identified forest land, wasteland, settlement, water bodies and agricultural land and found that the areas under agricultural lands have decreased and settlements have increased due to human interference.

Devi and Kumar (2011) examined that the increasing pressure of population can cause conversion of agricultural land into residential and industrial area. Giri (2012) applied technical, remote sensing methods and applications of land use and land cover with empirical examples at multiple scales.

Singh, Ashutosh et al. (2013) used a comparative approach using post classification change matrix and function change detection methodology for land use/land cover of Allahabad city. They used multispectral images of ETM+ and TM Landsat for fourteen classes of land use/land cover at ten year time period of 1990-2000.

Mukhopadhyay et al. (2013) analysed land use/land cover in Delhi using Landsat data and imageries. They classified imageries using Maximum Likelihood Classification algorithm. It is seen that the built-up area has extended outwards from the central eastern part t the rest of the region while fallow land and agricultural land has reduced.

Nagi, H. et al. (2013) studied mangrove habitats in Goa using the satellite data from IRS for three different periods (1997, 2001 and 2006). The mangrove habitats have increased by 22 percent during 1997 to 2006 due to invasion by mangroves of agriculture farms.

Pukhan P. et al. (2013) analysed land use/land cover changes in Golghat district of Assam using Landsat ETM for 1989 and IRS LISS III for 2009. The study revealed that the area under scrubland has transformed into agriculture crop therefore the area under cropland has increased by 18.10 percent during twenty years.

Sharma, M.P. et al. (2013) carried out land use/land cover study in Bhiwani district using IRS-P6 and LISS-III for the years 2005-06 and 2011-12. They used relative deviation formula for assessing accuracy of land use/land cover. The result shows that the built-up land increased by 0.74 percent while agricultural land has decreased by 0.76 percent during study periods. The study also shows that wastelands are reduced and the area under vegetation has increased due to forestation programme.

Dipanwita De et al. (2014) attempted to identify the land use/land cover changes in Panchrakhi village of Hugli District in West Bengal. The authors have accomplished plot to plot land use survey including categories (Agricultural land, Natural vegetation cover, Built-up area, Water bodies and Fallow land) based on the standard scheme classification.

Laishram M.D. et al. (2014) analysed the dynamics of land use/land cover in Manipur state during 1995-2010. They applied the Transition Probability Matrix for examining the dynamics of land use/land cover. They classified land use/land cover into eight categories i.e. settlement, agricultural land, forest, scrub land, shifting cultivation, barren land, wet lands and water bodies. The study concludes that increasing practice of shifting cultivation has adversely affected the dense forest cover while forest and water bodies have reduced in extent giving space to settlement and agriculture.

Nayak, L.T. (2014) focused on estimation of change in land use in Bellary district of Karnataka based on LULC maps prepared with the help of Multidata satellite imageries using remote sensing and GIS techniques. It has been observed that anthropogenic activities are proven to be more active agents for change of land use and land cover. It is evident that agricultural land with irrigation and forest land was diminished from 19911 to 2011 due to expansion of mining and built up area.

Sitaram and Paliwal (2014) prepared the thematic layers of land use/land cover patterns, their assessment, spatial distribution and extent with the help of Resourcesat (IRS P6) AWifs Standard False Colour Composite satellite images, SOI Topo maps. Supervised and unsupervised classification techniques were used to generate final land use/ land cover map.

Fazal, S. et al. (2015) examined land transformation and role of factors in deriving transformation in Aligarh city. The study highlighted that Aligarh city is growing at a fast rate, the demand for land is increasing. Therefore, it is encroaching fertile agricultural lands around the city.

Rawat and Kumar (2015) studied spatio-temporal dynamics of land/land cover of Hawalbagh block, Almora district in Uttrakhand using Landsat imageries of 1990 and 2010. They used maximum likelihood technique and categorized land use into five classes (built-up, agriculture, barren, vegetation and water body). During 20 years, builtup land and vegetation have been increased while agriculture, barren and water body have been decreased.

Rokde, J. et al. (2015) selected Salekasa tehsil of Gonda district in Maharashtra during 2001-2011. They aimed to produce a seasonal change in land use/land cover categories(built-up land, forest area, Waterbodies, cultivated land and scrub land) with two different approaches (census data and satellite data). The study concludes that the area under fallow is increasing and forest land is also improved while cultivable waste land is decreasing.

## Classification of Land Use

L.D. Stamp used the following classification for the land use mapping.

1. Land agriculturally unproductive, buildings, yards, mines, ponds,
2. Forest and woodlands,
3. Meadowland permanent grass
4. Heathland, moorland, commons, pastures,
5. Gardens,
6. Arable, fallow land.

The United States Geological Survey (USGS) developed land use and land cover maps of the US on scales $1: 250,000$ and $1: 100,000$ in 1976. The USGS developed a hierarchical classification scheme using level 1, level 2 and level 3 . The USGS adopted 9 classification of land use in level1 and 92 classifications in level 2. The USGS classified following nine classification according to level 1-

1. Built-up land
2. Agricultural land
3. Rangeland
4. Forest land
5. Water
6. Wetland
7. Barren land
8. Tundra
9. Perennial snow or ice

There were five classification of land use in India till 1949-1950. They were-

1. Forest
2. Area Not Available For Cultivation
3. Other Uncultivated Land Excluding Current Fallow
4. Fallow Land
5. Net Sown Area

This scheme of land use classification is not sufficient to meet the needs of planning. Therefore, the Government of India formatted technical committee on coordination of agricultural statistics in 1948, by the Ministry of Food and Agriculture. The Indian Council of Agricultural Research (1992) classified nine classification of land use which is as follows:

1. Forest,
2. Land put to non-agricultural use,
3. Barren and uncultivated land,
4. Permanent pastures and other grazing land,
5. Land under miscellaneous tree crops,
6. Cultivable waste lands,
7. Current fallow land,
8. Other fallow land,
9. Net area sown.

The National Remote Sensing Agency (1989) elaborated the land use/land cover classification according to needs of Indian condition following the USGS scheme of classification. The NRSA made 6 classifications in level 1 which are as follows

1. Built-up land,
2. Agricultural land,
3. Forests,
4. Wastelands,
5. Water bodies

## 6. Others

These categories are further subdivided into 21 categories in level 2.
The present study followed the scheme of classification of land use and land cover used by NRSA with slight modification.

## Agricultural Development

In the words of Gopalkrishnan (1992), "agricultural development is a multidimensional concept of which crop productivity is one of the vital aspects. Crop productivity is one of the vital aspects. Crop productivity is to be judged not merely from quantity of production but also from the variety and quality of the produce. The simplest and crucial measure of crop productivity is the yield per hectare of various crops."

Commercial crops are a good measure of agricultural development because it is market oriented cultivation and represents quality level of agriculture in an area. Commercialization of agriculture shows degree to which they operate will be the crucial factors in almost every question of agricultural development (Hunter, 1969).

The development of agriculture is also be determined by the degree of equity in farm incomes and agrarian relations (Davey, 1975).

Sharma, P.S. (1971) suggested that for assessing agricultural development, it should also be analysed physical inputs such as fertilizers, improved verities of seeds, irrigation and cultivated area with the estimation of level of productivity or trends in agricultural production.

Basu et al. (1979) define the agricultural development as "it denotes an overall increase in the use of inputs and higher returns (income) from land i.e. a concept roughly synonyms with that of green revolution. The concept of agricultural development is characterized by the higher yield or income per unit of land, as a result of the introduction of irrigation, compared to that of subsistence agriculture, which depend mostly on rainfall.

Food and Agricultural Organization (2006) study represents that use of fertilizers is basic determinant of agricultural development because use of fertilizers and manures increase agricultural efficiency and productivity to meet the demand of rising population.

Singh and Dhillon (1984) considered irrigation as a powerful source of agricultural development because inadequacy of irrigation hindrance in the agricultural production.

Therefore, agricultural development designates the quality of the agricultural system of a region in terms of productivity, diversification, and commercialization consistent with a desired state of agrarian relations and ecological balance. The level of agricultural development shows a picture prevailing at a particular time in time (Gopalkrishnan, 1992).

Dantwala and Donde (1949) studied the relationship between the size of land holding and small farmers' resources of cultivation in India. They analysed that poor performance of agriculture was due to uneconomic land holding and suggested that cooperative farming should be adopted for small farmers and also check large ownership. Jather and Beri (1949) considered that small land holdings and fragmentation of land is major cause for backwardness of Indian agriculture. They also delineated the causes and evils of fragmentation and subdivision of land.

Bhattacharaya (1949) attempted to analyse the failure of mechanization on Indian farming due to small size of land holding, pressure of population on land etc. the study recommended that steps should be carried in mechanization of Indian agriculture.

Brahamanand (1954) observed that Indian agriculture can not improved by only improvement in the productivity but also made efforts to reduce acceleration of population. Thirumalai (1954) found out the problems and policies of agriculture in India. He suggested that the use of technology and development programmes based on advance technology should be geared in a way to get immediate and long term gains. In his inaugural speech on the Fifteenth Annual Conference of the Association on Indian Agriculture Economics, Gadgil (1955) highlighted the need of a rational policy and
programme for creation of large consolidated holdings which are necessary for agricultural and land development.

Bater (1957) paid more attention to introduce the agricultural machinery and implements and their management to raise the agricultural production. Desai (1961) assumed that income and farm production could be raised through readjustment of existing resources. Rao, V.K. (1962) studied the relationship between cropping pattern and productivity during plan periods. He concluded that cropping pattern and productivity has not been recorded significant change over the decade.

Hopper (1963) carried out his study of economics of fertilizer use in Hoshangabad district of Madhya Pradesh. The study revealed that consumption of fertilizers is largely determined by their prices and analysed linear relationship between the output per acre and size of land holdings. Dandekar (1964) studied regional variation in agricultural development and productivity in West Bengal. He analysed that prevalence of tenancy conditions and continuous pressure of population on land were two main factors that embarrassed the pace of agricultural development.

Dayal (1966) calculated the progress of agricultural output about the 60 countries of the world during the period of 1952-53 and 1962-63 using semi log least square method. The variation in the rates of growth of crops is due to changes in farm land surface, changes in crop yield and cropping pattern.

George (1966) carried out his study in two groups of villages, one inside agricultural package area and the other outside. On the basis of data, he examined the significance of awareness and information $n$ the adoption of improved farm practices. He suggests that different methods of communication are effective way to maximize the intensity of information among cultivators.

Mitra (1967) selected following agricultural indicators for regional developmentpercentage of double cropped area, percentage of gross irrigated area, area under cash crops, percentage of households cultivating $0-5$ acres, percentage of pure tenancy
holdings, percentage of hired workers, percentage of agricultural workers and number of agricultural workers per 100 acres of net area sown.

Nath (1969) compared the level of agricultural development in different states of India through a composite index of indicators. He used three indicators i.e. growth rate of agricultural output, use of modern inputs and last productivity per hectare.

Tiwari (1970) attempted to study the relationship between agricultural development and population growth from 1951-1966. He observed that growth rate of agriculture is not more than the growth of population; hence the growth of per capita income is not sufficient.

Dasgupta (1973) studied agricultural and economic development in India over the period from 1955-56 to 1970-71. The study concluded that India's per capita income growth rate is definitely rise by increasing the productivity of labour in non-farm sector. Technological improvement in agriculture could change the prevailing trend of agriculture in India.

In his study of regional disparities of development in Andhra Pradesh, Alam (1974) applied six indicators for the agricultural sector, out of these, two related to productivity (agricultural output per agricultural worker and per acre) and four related to factors of agricultural development (percentage of gross irrigated area, gross cropped area, canal irrigated area and double cropped area).

Singh, D. and Singh, R. (1974) observed that unequal utilization of modern inputs was the main reason for inequality in income and poverty and also hindered the growth of development in Uttar Pradesh.

Hanumantha Rao (1975) discussed that technological changes such as tractorisation, fertilizers and use of HYV seeds are responsible for widening of in income disparities between different regions, small and large farmers, landowners and agricultural labourers.

Bhalla (1977) concluded that agricultural inputs and technology play a significant role in variation of output growth. He further suggested that increase in agricultural output is due to the improvement in infrastructure, acreage structure of landholdings and institutional factors.

Raza, M. (1978) has identified forty one indicators of agricultural development in his study of regional development in India. He has been presented these indicators into four subset groups of productivity, conditions of production, agrarian relations and change in agriculture.

Venkataran and Prahaladachar (1978) studied the changes in cropping pattern in Andhra Pradesh during 1950-51 to 1975-75. They analysed that farmers' behavior like profit maximization, risk aversion etc. plays dominant role in allocation of areas under major crops. The study also observed that the increase in area under rice, ragi and groundnut was an account of increase in prices of these crops.

Bhatia (1979) observed that agricultural output can be further pushed up through increasing use of fertilizers and irrigation particularly in states where the use of modern input has remained relatively low.

Gopalkrishnan (1979) stated that agricultural development may be predicted as the agricultural performance of an area in terms of economic profits, social justice and ecological balance. He has grouped the indicators of agricultural development into seven i.e. crop productivity, crop varieties, crop quality, diversification of agriculture, commercialization of agriculture, farm income and agrarian relations and farm management.

Utpal Baruah (1979) studied the role of high yielding varieties in agricultural development in agricultural development in Punjab and Haryana. He selected eight variables to explain the spatial variation of percentage of area under high yield varieties seeds to total cropped area belong to environment, technological, institutional, literacy and level of agricultural income of district. He concluded that use of HYV leads to substantial increase in yield rate and output.

Venkataraman and Prahaladachar (1980) attempted to study the growth rates in area, yield and output of major crops in the six states (Punjab, Rajasthan, Uttar Pradesh, Bihar, Maharashtra, and Andhra Pradesh) during 1950-1975. They identified the factors responsible for changing in cropping patterns in different states. The study revealed that an H.Y.V seed, fertilizers and irrigation has boosted the growth rates in Punjab whereas these factors are responsible for low growth rates in Rajasthan.

Ranade (1980) studied the impact of cropping pattern along with fertilizer and irrigation on agricultural production before and after the green revolution period. According to study, there exists a proportional relationship between cropping pattern index and agricultural productivity which is helpful in determining the extent of the use of high level technology and other such ingredients for pushing up the agricultural production.

Bagi, F.S. (1981) studied the economic contribution of irrigation to crop production in Haryana. He selected 119 individual farms and concludes that technical efficiency is higher in the irrigated farm.

Singh, Singh and Singh (1981) attempted to study the changes in the level of use of inputs in the selected crops. They selected a sample of 100 farmers randomly from the village of Sikrara Block of district Jaunpur in Uttar Pradesh who use new farm technology. The study concludes that technologies have proven to be better and more beneficial so that more labour jobs can be produced.

Eicher and Staatz (1984) contributed two articles in volume of 'Agricultural Development in Third War", one is political economy of rural development and other is related to land reforms. In these articles, they discussed poor condition of African agriculture and good achievements of Chinese agriculture.

Frank Penelope (1984) studied agricultural development of Japanese with the help of Japan model and Sage stage. This model explains that agriculture was the main source of small scale rural industries and also concerned benefits of new technology to middle scale cultivators.

Girippa and Vivekanand (1984) has discussed the impact of agro-climate and new technology on distribution of land, agriculture and trends in area, production, yield of major crops during 1970-71 to 1976-77. The study highlights that growth rate in area, production and yield has declined due to limited extension of modern inputs. He suggests that an alternative system of agricultural development should be developed for modernizing the process of production.

Jain, C.K. (1988) studied agricultural land use, cropping pattern, cropping intensity, agricultural productivity and levels of agricultural development in Madhya Pradesh. He emphasized to analyse the spatial variation of agricultural development in context of physio-socio-economic environment and critically analysis of trend of agricultural efficiency with changes in crop area and yield. For analyzing the spatial variation in agricultural development, he considered three indicators of output and eight indicators of input. Output indicators are agricultural productivity, value of crops per unit of cropped area and production of food grains per agricultural worker and inputs indicators are irrigated area, percentage cereal area under HYV seeds, use of fertilizers $\mathrm{kg} /$ hectare of cropped area, pumping sets, electric pumps, tractors, iron plough and carts.

Thakur (1992) explained district wise agricultural growth in Bihar taking average data for 1963 and 1973. He considered 17 major crops that accounted more than 80 percent area of total cropped area. Further, he analysed his study in four phases i.e. changing pattern of land use, changing pattern of crop land use, growth in area and output in major crops and overall growth at state level in monetary value. The study concluded that due to introducing new policies and programmes in agriculture, all the variables of agricultural development have undergone a change.

Bhadrapur and Naregal (1992) examined the levels of agricultural development in Bellary district with the help of 18 indicators through Kendall's ranking coefficient method during 1975-76 and 1985-86. The study revealed that physical, social and environmental factors create a lot of variation in the levels of agricultural development.

Raja ram (1993) assessed the agricultural growth and impact of Command Area Development Program in area of land use, cropping intensity, cropping pattern, use of fertilizers, production etc.

Singh, A. (1995) analysed the influence of important factors on the cropping pattern in Muzaffarnagar district using multiple linear regression equation. The important factors affecting acreage of different crops considered were price, production, irrigated area and acreae of a crop in the preceding year.

Sawant et al. (1999) have studied the agricultural growth in Maharashtra from 1967 to 1993 by focusing on interrelationship between input use and output growth. They have also analysed the causes of growth performance and found out that aggregates growth performance of the crops goes down after 1991. The study concludes that yield of crops has slipped down and the aggregate output has decelerated due to increase in rates of inputs such as fertilizers, pesticides, electricity etc. unfavorable rainfall condition was also partial responsible causes for worsening of the growth.

Dhindsa and Shrama (2001) deal the policies, planning and liberalization in Indian agriculture after independence. They considered the price of crops, a special dimension of agricultural development and help in reducing poverty.

Roy and Bezbaruah (2002) analysed trends in production and productivity of the major crops in Barak valley in the state of Assam since mid-1970s and identified a no. factors like adoption of HYV of Rice, modern varieties, irrigation facilities, application of chemical fertlisers, farm size, tenurial status of farmers and improved practices that is used by the farmers of the region have dependent under different socio-economic and geographical condition.

Mathur, Dar and Sarcer (2006) have identified factors affecting in growth of agriculture using Cobb-Douglas production method. They highlighted that role of public investment/government expenditure on agriculture play a major role in carrying out the rate of growth of agricultural production. Other factors like use of fertilizers and agricultural prices also effect the agricultural growth.

Agarwal, M. and Singh D. (2007) attempted to analyse changes in cropproduction and productivity, evaluation of agricultural productivity and relationship between spatial variation in productivity and levels of adoption of yield raising inputs in Pardaha block of Mau District. They adopted composite index method including input and output. They analysed that the gross cropped area and the irrigated area are increased due launching of new programmes and policies. They also described that agricultural development and productivity has been increased certainly with the changes in traditional agricultural practices.

Ghosh, M. (2009) examined growth in agriculture and regional variation in rural poverty in India between 1972-73 and 2004-05 by using OLS method. He analysed that the benefits of growth in agriculture impact to the rural poor but the inclusiveness of growth have limited and weakening with time.

Mohanty, B.B. (2009) studied the regional inequality in agricultural development in Maharashtra. He carried out impact of establishment of agro-processing industries, nearness of market for modern appliances and socio-cultural proximity on agricultural development of a region.

Sharma, S.S.P. (2009) examined the emerging changes in agricultural development and its impact on rural poverty and environmental degradation in West Bengal with the help of primary as well as secondary data. He studied how the agricultural growth reduced rural poverty and their impacts on environment.

Jain, G.L. (2010) described that increase in yield, production, cropping intensity in India after independence depends upon many factors like irrigation facilities, use of fertlisers, appropriate crop rotation, selective mechanization, introduction of HYV, plant protection measures, soil improvements etc.

Diwan (2012) highlighted the innovations in agricultural land use in Gumla District. It is reacted primarily with the adoption process and spread of the new agricultural technology which ensures sustained increase in agricultural productivity.

Patil (2012) analysed the spatial pattern and levels of agricultural development in northern part of Nandubar district. He selected nine indicators in terms of technological, social and economic factors for measuring the level of agricultural development. He concluded that those areas are highly developed, where cash crops and agro-based industries are well developed.

Raman et al. used thirteen indicators to analyse the regional disparity in agricultural development in Uttar Pradesh. They used UNDP methodology to standarise agricultural indicators for agricultural attainment in state. The authors concluded that if the development policy has to be taken, committed efforts of the policy makers are essential.

Khan and Khalil (2013) studied the level of agricultural development in Dehradun. They concluded that upper central part of district experienced high level of agricultural development due to better irrigation facilities, high cropping intensity, plenty of agriculture workers and high production of food grains.

Kumar and Jain (2013) examined the trends and instability in Indian agriculture. The analysis of study revealed that modern inputs play important role in enhancing the productivity of crop sector. The use of fertilizers, sources of irrigation, rainfall, better human resource and road connectivity are important determinants in enhancing the agricultural productivity, therefore, it requires proper management in any region.

Mishra and Sarkar (2013) emphasized on technological applications and use of modern agricultural inputs to enhance the productivity from fixed cropland. They analysed the root causes of spatial imbalances in crop productivity and the levels of agricultural development in Chanduli District of Eastern Uttar Pradesh. Agricultural productivity is computed by four indices i.e. (i) weighted crop equivalent index, (ii) standardized yield index, (iii) cropping intensity index and (iv) agricultural worker index. The levels of agricultural development are estimated by data integration overlying method (GIS).

Rukhsana and Alam (2014) studied the regional pattern of agricultural development and food security in Koch Bihar district of West Bengal. The authors have selected 20 indicators in order to get the indexes of agricultural development and food security. It has been found that agricultural development is positively related with food security.

Kumar, N.P. (2015) assessed the extent of inter-district disparities in agricultural development of Uttar Pradesh using multivariate analysis. The three years i.e. 2000-2001, 2005-06 and 2009-10 have been chosen to observe the variation. It is initiated that Western U.P. enjoys comparatively better status in the field of agriculture than Central, Eastern and Bundelkhand Region.

Shamsad (2015) studied land use and development in West Bengal from 19852009. He found out the relationship between the land use categories and socio-economic development. He concluded that workers engaged as agricultural labour is principal element for net sown area.

It is evident from the overview of literature; no work has been made on land use/land cover, agricultural development in Aligarh district. Amani in 1976 has studied land use of four villages in Aligarh district and Fazal (2014) has worked on transformation of land use only in Aligarh city. There is a need to study detail and comprehensive work on block wise variation of land use/land cover with help of remote sensing data and agricultural development in Aligarh district

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CHAPTER-3
$\mathcal{L A N D}$ USE PATIERN

Land is the most important natural resource of the country. The proper use of land according to its capability is a matter of utmost concern ensuring the future need of the nation. The responsibility of the present generation is to use this vulnerable resource in such manner that it could be safe for future generation (Memoria, 1984). Land use is a combined result of the natural set-up and human dynamism within the socio-economic set-up and technological development. Land use of a country at any particular time is determined by the physical, economic and institutional framework taken together (Tyagi, 1998). Land use pattern of a region is a dynamic, modified by nature and human beings. The human beings obtain their basic and essential needs from environment, so they have been modified the land. There are a number of factors like social, economic and technical factors that affect the land use pattern over time and space. Change in land use and land cover has become an important component in current strategies for managing natural resources and environmental changes (Hangaragi, S.S., 2011). Therefore, this chapter includes pattern of land use/land cover, changes in land use/land cover in Aligarh district as well as in blocks of Aligarh district from 1996 to 2011 with the help of Remote Sensing and Geographic Information System. The satellite Remote Sensing and Geographic Information System techniques are useful tools for assessing the land use/land cover which is one of the important aspects for planning and development of an area (Gaur, M.K. 2011).

### 3.1 Land Use/ Land Cover in Aligarh District (1996-2011)

The study has been carried out for fifteen years (from 1996 to 2011) to analyze the changes in land use. The share of various land use categories along with the total area and their percentage to the total geographical area are shown in table 3.1. The change matrix table 3.2 shows the interchange of land between land use classes. Land use change matrix is a process of identifying and analyzing the differences of an object or a phenomenon through monitoring at different times (Singh, 1989). In the present study, a total of eight land use/land cover classes have been taken for study which include Builtup land, Agricultural land, Fallow land, Vacant land, Water Bodies, Wet land and Tree Plantation.

## Built-up Land

Built-up land is an area of human habitation developed due to non-agricultural uses i.e. settlements, buildings, industrial area, highways, transportation and communication, other civic facilities and amenities etc. It is represented by the red colour on the imageries. It is evident from the table 3.1 that the area under built-up land was reported as 9507.77 hectares which was 2.59 percent to the total geographical area in 1996 and 25154.33 hectares which was 6.85 percent to the total geographical area in 2011. The remarkable growth has been observed under built-up land i.e. increase of 4.26 percent during 1996 to 2011. This remarkable growth under built up land has been recorded due to conversion of agricultural lands into urban areas, cutting down of trees for the construction of shops, restaurants, dhabas along the roads and highways. Vacant land has been also converted into settlements around the city due to excessive pressure of population on land.

It is clear from the table 3.2 that total 9905.54 hectares agricultural lands changed into the built-up land class. The area under tree plantation i.e. 1073.18 hectares also converted into built-up land. Tree plantation is appeared more along the roads in the year of 1996 whereas that built-up area is seen along the roads in the year of 2011 (Figure 3.3 and 3.4).

## Agricultural Land

Agricultural land is primarily used for cultivation of different crops include cereals, oilseeds, pulses and other horticulture and commercial crops. It is actually crop land. It is shown by yellow colour on imageries.

Although agricultural land has been lost its area at a great level in Aligarh district, it has been recorded positive growth during 1996-2011. It increased from 289428.20 hectares ( 78.86 percent to the total geographical area) in 1996 to 300101.68 hectares (81.77 percent to the total geographical area) in 2011. Agricultural land was increased by 2.91 percent during these fifteen years. The main reason behind it is that the converted area of vacant land into agricultural land is more than the converted area of agricultural
land into built up land. It is observed from the table 3.2 that 9905.54 hectares and 4568.21 hectares of agricultural land have been changed into built-up land and vacant land respectively. It is clear from the figure 3.6 that agricultural land has been converted into vacant land around Aligarh city and other towns of Aligarh district. Agricultural land has also changed into brick-kilns in south-west part of Gangiri block and north-east of Akrabad block. About 150 brick-kilns have made in place of agricultural land. A vast area of crop land has lost in this place. The reason for it is availability of water from Kali River and soil is also suitable for making bricks.

Table 3.1
Land Use/ Land Cover of Aligarh District, (1996 and 2011)

| Land Use/ <br> Land Cover <br> Classes | 1996 |  | 2011 |  | Changes <br> from 1996 <br> to 2011 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 9507.77 | 2.59 | 25154.33 | 6.85 | $\mathbf{4 . 2 6}$ |
| Agricultural <br> Land | 289428.20 | 78.86 | 300101.68 | 81.77 | $\mathbf{2 . 9 1}$ |
| Fallow Land | 7482.02 | 2.04 | 3103.21 | 0.85 | $\mathbf{- 1 . 1 9}$ |
| Vacant Land | 31616.33 | 8.61 | 12601.41 | 3.43 | $\mathbf{- 5 . 1 8}$ |
| Tree <br> Plantation | 14441.73 | 3.93 | 12405.52 | 3.38 | $\mathbf{- 0 . 5 5}$ |
| Water Bodies | 1860.75 | 0.51 | 2078.32 | 0.57 | $\mathbf{0 . 0 6}$ |
| Wet Lands | 11381.98 | 3.10 | 8735.44 | 2.38 | $\mathbf{- 0 . 7 2}$ |
| Sandy Area | 1300.34 | 0.35 | 2839.21 | 0.77 | $\mathbf{0 . 4 2}$ |
| Total | 367019.12 | 100.00 | 367019.12 | 100.00 | $\mathbf{0 . 0 0}$ |

Source: Landsat 5 data, 1996 and 2011

Table 3.2 further shows that the total area lost by agricultural land is 23945.35 hectares whereas the total area achieved by the agricultural land is 34618.83 hectares out of which 18519.41 hectares area has been gained from vacant land and 6376.03 hectares area from tree plantation. Achieved area by agricultural is more than the reduced area,
due to this reason, agricultural land recorded positive growth but there is no space for increasing agricultural land because vacant land has almost finished.

## Fallow land

National Remote Sensing Agency (1988-89) defined the fallow land as "it is described as agricultural land which is taken up for cultivation but is temporarily allowed to rest un-cropped for one or more seasons, but not less than one year. These lands are particularly those which are seen devoid of crops at the time when the imagery is taken of both seasons."

Out of the total geographical area of the Aligarh district, fallow land contributed only 2.04 percent in 1996 and 0.85 percent in 2011. It declined by 1.19 percent from 1996 to 2011. The change matrix table shows that 7130.82 hectares fallow land has been changed into agricultural land and 2889.48 hectares agricultural land has been converted into fallow land in 2011. There is 137.47 hectares fallow land which has been transformed into tree plantation.

## Vacant Land

Vacant lands are no use of land and it is the process of change of conversion. The land owners have kept vacant lands due to steeply rising price of lands. It is observed from the figure 3.6 that vacant land has been converted into agricultural land and built-up land. The vacant land has been converted into built-up land around city and towns whereas in other parts of district vacant land (barren land) has been changed into agricultural land. It is evident from the table 3.1 that about one fourth of vacant land was remained in 2011.

It is seen from the figure 3.4 and 3.5 that vacant land are appeared more in the central part of the district. Table 3.1 shows that vacant land comprised 31616.33 hectares (8.61 percent to the total geographical area) in 1996 and it reduced to 12601.41 hectares (3.43 percent to the total geographical area) in 2011. Vacant land was declined by 5.18 percent during the span of fifteen years. It is evident from the table 3.2 that 4073.62 hectares (12.88 percent) vacant land has been converted into built-up land whereas


Figure 3.1

Land use/ Land cover in Aligarh District, 2011

$\square$ Built-up Land
$\square$ Agri. Land
$\square$ Fallow land
$\square$ Vacant Land
-Tree Plantation

- Water Bodies
$\square$ Wet
■ Sandy Area

Figure 3.2
18519.41 hectares ( 58.57 percent) vacant land has been transformed into the agricultural land in the year of 2011. It assumes that vacant land will be totally finished in coming years, then the area of agricultural land will be reduce at great level. The remaining vacant land has been also changed into other classes of land use.

## Tree Plantation

It is described as an area under agricultural tree crops, trees, plantation adopting certain agricultural techniques. In Aligarh district, the proportion of forest area is negligible. The total area under tree plantation registered as 14441.73 hectares ( 3.93 percent to the total geographical area) in 1996 whereas it recorded as 12601.41 hectares ( 3.43 percent to the total geographical area) in 2011. It is clearly seen from the figure 3.3 and 3.4 that tree plantation is appeared more in the eastern part of the district in both years and is also seen along the roads and canals. Figure 3.6 shows that tree plantation recorded positive growth in the eastern part and negative growth in the western part of the district in the year of 2011. The positive growth in eastern part is due to increasing mango and guava plantation. Govt. of India has also launched programme for high density planting and promotion of rejuvenation of senile, old and unproductive orchards of mango and guava. However, tree plantations have cleared for the construction of schools, colleges, shops, malls, etc. along the highways or main roads.

The change matrix table clearly indicates that 1073.18 hectares area of tree plantation has been changed into built-up area while the other 6376.03 hectares tree plantation area has been altered into agricultural land. There are only 5695.21 hectares areas of tree plantation which remained under tree plantation in 2011. Some parts of tree plantation have been changed into water bodies, wet lands and sandy area. The tree plantation area which was appeared along the canals in 1996, it seems as wet lands in 2011 (Figure 3.4).

## Water Bodies

This category comprises area with surface water in the form of ponds, lakes, tanks and reservoirs. The Ganga and the Yamuna are main rivers which flow in Aligarh


Figure 3.3


Figure 3.4

Table 3.2
Change Matrix of Land Use/Land Cover in Aligarh District (1996-2011)

| Classes | Built-up <br> Land | Agricultural <br> Land | Fallow <br> Land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Lands | Sandy Area |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | $\mathbf{9 2 7 1 . 7 4}$ | 79.71 | 0.00 | 55.60 | 92.84 | 3.00 | 4.88 | 0.00 |
| Agricultural <br> Land | 9905.54 | 265482.85 | 2889.48 | 4568.21 | 4950.70 | 67.22 | 1285.99 | 278.21 |
| Fallow land | 0.00 | 7130.82 | $\mathbf{2 1 3 . 7 3}$ | 0.00 | 137.47 | 0.00 | 0.00 | 0.00 |
| Vacant <br> Land | 4073.62 | 18519.41 | 0.00 | 7710.50 | 652.79 | 33.00 | 472.75 | 154.26 |
| Tree <br> Plantation | 1073.18 | 6376.03 | 0.00 | 263.68 | 5695.21 | 99.63 | 918.32 | 15.68 |
| Water <br> Bodies | 17.21 | 175.49 | 0.00 | 3.42 | 119.80 | $\mathbf{1 1 5 1 . 8 2}$ | 277.98 | 115.03 |
| Wet Lands | 796.56 | 2200.30 | 0.00 | 0.00 | 753.83 | 584.93 | 5728.17 | 1318.19 |
| Sandy Area | 16.48 | 137.07 | 0.00 | 0.00 | 2.88 | 138.72 | 47.35 | $\mathbf{9 5 7 . 8 4}$ |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011
district. Other seasonal rivers are Nim, Kali, Sengar, and Karwan. The satellite images have been taken in the month of February in 1996 and 2011. Therefore, the volume of waters is low due to seasonal variation. They have large volume of water in the monsoon season. It is seen from the figure 3.3 and 3.4 that the Ganga and the Yamuna rivers have changed their course during one and half decades. The Yamuna river is shifting from west to east. The area under water bodies seems more or less constant during span of fifteen years. It covers low proportion of geographical area of the district. It covered 1860.75 hectares ( 0.51 percent) in 1996 and 2078.32 hectares ( 0.57 percent) in 2011. Only 0.06 percent positive change has been recorded under water bodies. It may see from the figure 3.3 that upper Ganga canal passes in the middle part of the district. It crosses Jawan, Dhanipur and Akrabad block. In Akrabad block, it is bifurcated into two branches for irrigation purposes.

Table 3.2 shows that 1151.82 hectares areas have no transformation and remaining areas of water bodies have been changed into other classes of land use, out of which a large proportion of water bodies (277.98 hectares) have been converted into wet lands.

## Change in Land use/Land cover in Aligarh District (1996-2011)



Figure 3.5


Figure 3.6


Plate 1.
Vacant Land

Plate 2.
Construction of building in place of agricultural land


Plate 3.
Transformation
of agricultural
land into vacant
land for the purpose of settlement around Aligarh city

## Wet Lands

Wet lands are swampy areas which are situated on the margins of lakes, ponds and streams and rivers. The water level is high in these areas all around the year. It covered 11381 hectares area ( 3.10 percent) in 1996 which has decreased to 8735.44 hectares ( 2.38 percent) in 2011. A large portion of wet lands have seen in the east part of the district. It lies between the Ganga river and the lower Ganga Canal. This area is either totally marshy land or cultivable land. Table 3.2 represents that 2200 hectares wet lands have been transformed into agricultural lands. No changes observed in the area of 5728.17 hectares of wet lands. The wet lands area is also cultivated in some places of district.

## Sandy Area

Sandy areas occur in coastal, riverine or inland areas. In Aligarh district, sandy areas are found along the Ganga and the Yamuna rivers. They are called as riverine sands. Riverine sands are those that are seen as accumulations in the flood plain as sheets which are the resultant phenomena of river flooding. It is revealed from the table 3.1 that the total sandy area was 1300.34 hectares ( 0.35 percent to the total geographical area) in 1996 and registered 2839.21 hectares ( 0.77 percent to the total geographical area) in 2011. During 1996-2011, the sandy area was increased by only 0.42 percent. It increased due to change course of the rivers. The change matrix table reveals that sandy area has also been converted into agricultural land, water bodies and wet lands.

### 3.2 Accuracy Assessment

Accuracy assessment is an important aspect to estimate the reliability of the classified map. Various geographers and scientists like Aronoff (1982), Conglaton (1991), Stehman and Czaplewski (1998), Koukoulas and Blackburn (2001), Foody (2002) and others have discussed different approaches to assess the accuracy level. The most widely prompted technique is error matrix or confusion matrix for accuracy assessment. This technique measures samples units which are taken from a particular category of the classified map relative to the actual category verified from the ground.

Table 3.3

## Error Matrix table of Accuracy Assessment of Land use/Land cover Map, 2011

|  | Built-up <br> Land | Agri. <br> Land | Fallow land | Vacant <br> Land | Tree Plantation | Water <br> Bodies | Wet Lands | Sandy Area | Total | User's <br> Accuracy |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up Land | 18 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 19 | 94.74 |
| Agri. Land | 0 | 25 | 0 | 0 | 2 | 0 | 1 | 0 | 28 | 89.29 |
| Fallow land | 0 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 6 | 66.67 |
| Vacant Land | 1 | 0 | 1 | 11 | 0 | 0 | 0 | 0 | 13 | 84.62 |
| Tree Plantation | 0 | 1 | 0 | 0 | 16 | 0 | 1 | 0 | 18 | 88.89 |
| Water Bodies | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | 100.00 |
| Wet Lands | 0 | 3 | 0 | 0 | 0 | 0 | 5 | 0 | 8 | 62.50 |
| Sandy Area | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 100.00 |
| Total | 19 | 29 | 5 | 14 | 18 | 6 | 7 | 2 | 100 |  |
| $\begin{gathered} \text { Producer's } \\ \text { Accuracy (\%) } \end{gathered}$ | 94.74 | 86.21 | 80.00 | 78.57 | 88.89 | 100.00 | 71.43 | 100.00 |  |  |
| $\begin{gathered} \text { Overall Accuracy }=87.00 \text { Percent } \\ \text { Kappa Statistics }=0.842 \end{gathered}$ |  |  |  |  |  |  |  |  |  |  |

Source: Computed by Researcher

In the error matrix table, the rows represent classified land use map derived from remote sensing whereas the columns represents the reference data that were collected from ground data. Overall accuracy, kappa coefficient value, producer accuracy and user accuracy of each class can also be measured from this table.

Overall accuracy measures percentage of correct points to the total sample points. User's accuracy can be obtained by dividing the correct points in a class by the total number of points in that class while producer's accuracy is calculated by dividing the number of correct sampling points in a class dividing by the total number of points as derived from reference data. Kappa coefficient is one of the discrete multivariate techniques which is used to evaluate the chance of agreement. Cohen developed this statistics in 1960 but Congalton introduced this technique in remote sensing in 1983.

Assessment of accuracy has been done by employing error matrix technique for a total of 100 random sample points for only 2011 classified map. It is verified with the help of Google earth imagery and Global Positioning System on ground. It has not been calculated for 1996 map because a lot of changes have occurred on ground and high resolution imagery of Google earth is not available before the period of 2002. On the basis of 100 sampled points, overall accuracy of different land use classes is 87.00 percent i.e. good accuracy and overall kappa statics is 0.842 . It means that there is 84.20 percent better agreement than by chance alone. Producer accuracy of built-up land, agricultural land, fallow land, vacant land, tree plantation, water bodies, wet lands and sandy area are 94.74 percent, 86.21 percent, 80.00 percent, 78.57 percent, 88.89 percent, 100 percent, 71.43 percent and 100 percent respectively while user's accuracy of these classes are 94.74 percent, 89.29 percent, 66.67 percent, 84.62 percent, 88.89 percent, 100 percent, 62.50 percent and 100 percent respectively. The accuracy of wet lands is low because crop with irrigation match with wet lands.

The block-wise share land use classes may be seen from the figure 3.7, 3.8 and block-wise changes during 1996 to 2011 may also be seen from the figure 3.9 at a glance.


Figure 3.7


Figure 3.8


Figure 3.9

### 3.3 Block-Wise Land Use/Land Cover in Aligarh District (1996-2011)

## Tappal Block

The details of land use/land cover of Tappal block for the year 1996 and 2011 is given in the table 3.4. This table shows that built up land and sandy area registered a positive growth while as other classes of land use witnessed a negative growth during span of fifteen years. Built up land constituted 2.10 percent of the area in 1996 and 5.09 percent in 2011, thus, registering a positive change of 2.99 percent from 1996-2011.

There is 1013.42 hectares agricultural land, 142.11 hectares vacant land and 7.28 hectares tree plantation which have been transformed into built up land from 1996 to 2011. Agriculture land registered a decrease from 34218.22 hectares area ( 88.71 percent) in 1996 to 33155.92 hectares area ( 85.96 percent) in 2011, therefore, showing a negative change of 2.75 percent. The negative growth of agricultural land in this block is due to newly created Yamuna Express Highway in 2011. The total 2057.43 hectares area has been achieved by agricultural land whereas 2057.69 hectares area has been deducted from agricultural land.

Fallow land and vacant land registered a negative change of 0.20 percent and 1.10 percent during 1996-2011. Table 3.5 shows that 535.34 hectares agricultural land has been converted into vacant land for the purpose of built-up land around the towns whereas 743.84 hectares vacant land has been changed into agricultural land during fifteen years. There is only 82.33 hectares vacant land which remained in 2011. It is seen from the figure 3.11 that one highway is passing across Tappal block in 2011. This highway is known as Yamuna expressway that joins Delhi to Agra. According to available notification of Govt. of Uttar Pradesh, 17 villages of Tappal block have given their fertile agricultural land for construction of this highway. In the figure 3.11, a large area of vacant land is seen in the middle of block adjacent to highway. It is seen as vacant because when express way was under construction, the construction material deposited here, after it, this area becomes waste land and appears as vacant land.

The area under tree plantation has shown a substantial decrease of 1.45 percent

Table 3.4
Land use/Land Cover of Tappal Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 811.09 | 2.10 | 1963.25 | 5.09 | 2.99 |
| Agricultural <br> Land | 34218.22 | 88.71 | 33155.92 | 85.96 | -2.75 |
| Fallow Land | 380.89 | 0.99 | 305.12 | 0.79 | -0.20 |
| Vacant Land | 1065.2 | 2.76 | 638.87 | 1.66 | -1.10 |
| Tree Plantation | 984.72 | 2.55 | 433.05 | 1.12 | -1.43 |
| Water Bodies | 228.64 | 0.59 | 208.27 | 0.54 | -0.05 |
| Wet Lands | 774.19 | 2.01 | 664.11 | 1.72 | -0.29 |
| Sandy Area | 109 | 0.28 | 303.36 | 0.79 | 0.51 |
| Total | 38571.95 | 100 | 1963.25 | 5.09 |  |
| Sount Lans | 1996 |  |  |  |  |

Source: Landsat 5 data, 1996 and 2011
Table 3.5
Change Matrix Table of Tappal Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> lad | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land | Sandy <br> Area |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 774.80 | 25.08 | 0.00 | 11.21 | 0.00 | 0.00 | 0.00 | 0.00 |
| Agri. <br> Land | 1013.42 | 31098.23 | 299.12 | 535.34 | 56.66 | 41.67 | 132.78 | 141.0 |
| Fallow <br> land | 0.00 | 368.89 | 6.00 | 0.00 | 6.00 | 0.00 | 0.00 | 0.00 |
| Vacant <br> Land | 142.11 | 743.58 | 0.00 | 82.33 | 22.51 | 0.00 | 74.67 | 0.00 |
| Tree <br> Plantation | 7.28 | 494.84 | 0.00 | 9.99 | 310.01 | 26.12 | 136.48 | 0.00 |
| Water <br> Bodies | 17.21 | 99.92 | 0.00 | 0.00 | 14.41 | 36.23 | 36.51 | 24.36 |
| Wet <br> Land | 8.43 | 325.38 | 0.00 | 0.00 | 23.46 | 92.25 | 273.67 | 51.00 |
| Sandy <br> Area | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 10.00 | 87.00 |

[^0]

Figure 3.10
Figure 3.11


Figure 3.12
from 1996-2011. It was 2.55 percent in 1996 and 1.10 percent in 2011. The area of tree plantation has been changed into built-up land and agricultural land by 7.28 hectares and 494.84 hectares respectively.

The area under Water bodies was more or less same in both the years. It was 0.59 percent and 0.54 percent in 1996 and 2011 respectively. Wet lands decreased by 0.29 percent during 1996-2011. Sandy area of Tappal block comprised 0.28 percent in 1996 which increased to 0.79 percent of the total area in 2011, thus registering a positive net change of 0.51 percent.

## Khair Block

It is seen from the table 3.6 that the built-up area recorded 741.12 hectares (2.04 percent to the total geographical area) in 1996 which inclined up to 2153.80 hectares (5.94 percent to the total geographical area) in 2011. The positive change under this category of land use is observed by 3.90 percent during 1996-2011. The area under agricultural land registered 3.38 percent positive change from 1996 to 2011. It increased from 30635.26 hectares in 1996 to 31496.57 hectares in 2011 which was 84.48 percent and 86.85 percent to the total geographical area respectively. It is quite obvious from the table 3.7 that 3.50 percent of agricultural land i.e. 1077.77 hectares have been changed into built-up land. There are 238.07 hectares and 35.33 hectares lands which have been transformed into vacant land and wet land respectively.

Fallow land covered only 1.16 percent in 1996 and 0.75 percent in 2011. It was decreased by 0.35 percent during this period. Table 3.7 shows that 409.61 hectares area of fallow land has been transformed into agricultural land.

Vacant land has 2681.04 hectares area ( 7.39 percent) in 1996 which decreased to 912.73 hectares ( 2.52 percent) in 2011. During 1996-2011, it was decreased by 4.88 percent. In this block, 209.19 hectares vacant lands have been altered into built-up land whereas 1754.91 hectares vacant land ( 65.78 percent of total vacant land in 1996) has been converted into agricultural land. Out of total vacant area in 1996, only 13.40 percent areas are remained as vacant.

Table 3.6
Land use/Land Cover of Khair Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 741.12 | 2.04 | 2153.80 | 5.94 | 3.90 |
| Agricultural Land | 30635.26 | 84.48 | 31496.57 | 86.85 | 2.38 |
| Fallow land | 420.79 | 1.16 | 270.44 | 0.75 | -0.41 |
| Vacant Land | 2681.04 | 7.39 | 912.73 | 2.52 | -4.88 |
| Tree Plantation | 813.81 | 2.24 | 413.41 | 1.14 | -1.10 |
| Water Bodies | 194.21 | 0.54 | 198.25 | 0.55 | 0.01 |
| Wet Lands | 778.41 | 2.15 | 819.44 | 2.26 | 0.11 |
| Total | 36264.64 | 100.00 | 36264.64 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.7
Change Matrix Table of Khair Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> Land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-Up <br> Land | 729.36 | 0.55 | 0.00 | 5.82 | 5.39 | 0.00 | 0.00 |
| Agri. <br> Land | 1077.77 | 28988.68 | 261.12 | 238.07 | 29.17 | 5.12 | 35.33 |
| Fallow <br> Land | 0.00 | 409.61 | 9.32 | 0.00 | 1.86 | 0.00 | 0.00 |
| Vacant <br> Land | 209.19 | 1754.91 | 0.00 | 659.23 | 23.78 | 7.21 | 26.72 |
| Tree <br> Plantation | 130.52 | 309.16 | 0.00 | 9.61 | 296.13 | 16.09 | 52.30 |
| Water <br> Bodies | 0.00 | 13.70 | 0.00 | 0.00 | 28.30 | 135.01 | 17.20 |
| Wet <br> Land | 6.96 | 19.96 | 0.00 | 0.00 | 28.78 | 34.82 | 687.89 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.13
Figure 3.14


Figure 3.15

The area under tree plantation recorded 813.81 hectares ( 2.24 percent) in 1996 and 413.41 hectares ( 1.14 percent) in 2011. It was declined by 1.10 percent during 1996 to 2011. Table 3.7 shows that a major proportion of tree plantation in Khair block has been transformed into agricultural land while remaining area of tree plantations has been converted into built-up land and wet lands.

No change has been recorded under the area of water bodies and wet lands. There is one canal in this block which is dry in winter season so this canal appears as wet lands in imageries. The area under wet land increased from 2.15 percent in 1996 to 2.26 percent in 2011.

## Chandaus Block

The details of land use classes of Chandaus block are shown in the table 3.8 and the details of the changes of land use classes are depicted in the table 3.9. It is seen from table 3.8 that built-up land occupied 743.54 hectares ( 2.36 percent) area in 1996 and 1709.83 hectares ( 5.43 percent) area in 2011. It was increased by 3.07 percent from 19962011. After Jawan, Chandaus block recorded maximum positive growth in agriculture area by 6.80 percent during the span of fifteen years. It increased from 80.75 percent in 1996 to 87.56 percent in 2011. The increasing growth in agriculture has been registered due to conversion of vacant land into agricultural land at a high rate and progress in builtup area at a low rate. There is a 787.12 hectares land of agriculture which has been transformed into built-up land.

Except Gonda and Iglas, all blocks registered negative growth in fallow land. In Chandaus block, the fallow land comprised 744.29 hectares ( 2.36 percent) area in 1996 and 349.95 hectares ( 1.11 percent) in 2011. It was declined by 1.25 percent from 1996 to 2011. There is 722.01 hectares fallow land which has been transformed into agricultural land. It was about 97 percent area of total fallow land, registered in 1996.

The area covered by vacant land was 3144.1 hectares ( 9.99 percent to the total geographical area) in 1996 and it was 770.22 hectares ( 2.45 percent to the total geographical area) in 2011. During this period, the decline was by 7.54 percent in vacant

Table 3.8
Land use/Land Cover of Chandaus Block, (1996 and 2011)

| Land Use/ Land | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Cover Classes | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 743.54 | 2.36 | 1709.83 | 5.43 | 3.07 |
| Agricultural Land | 25426.50 | 80.75 | 27568.24 | 87.56 | 6.80 |
| Fallow land | 744.29 | 2.36 | 349.95 | 1.11 | -1.25 |
| Vacant Land | 3144.10 | 9.99 | 770.22 | 2.45 | -7.54 |
| Tree Plantation | 957.87 | 3.04 | 665.93 | 2.11 | -0.93 |
| Water Bodies | 44.55 | 0.14 | 74.30 | 0.24 | 0.09 |
| Wet Lands | 425.48 | 1.35 | 347.86 | 1.10 | -0.25 |
| Total | 31486.33 | 100 | 31486.33 | 100 |  |

Source: Landsat 5 data, 1996 and 2011
Table 3.9
Change Matrix Table of Chandaus Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 713.14 | 4.60 | 0.00 | 3.80 | 22.00 | 0.00 | 0.00 |
| Agri. <br> Land | 787.12 | 23947.50 | 329.67 | 179.01 | 65.69 | 20.43 | 97.08 |
| Fallow <br> land | 0.00 | 722.01 | 20.28 | 0.00 | 2.00 | 0.00 | 0.00 |
| Vacant <br> Land | 144.23 | 2309.17 | 0.00 | 578.41 | 24.08 | 0.00 | 88.21 |
| Tree <br> Plantati <br> on | 50.23 | 352.34 | 0.00 | 9.00 | 535.20 | 11.10 | 0.00 |
| Water <br> Bodies | 0.00 | 8.28 | 0.00 | 0.00 | 1.98 | 30.95 | 3.34 |
| Wet <br> Land | 15.11 | 224.34 | 0.00 | 0.00 | 14.98 | 11.82 | 159.23 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.16
Figure 3.17


Figure 3.18
land. About 73 percent of vacant land of 1996 has been changed into agricultural land in 2011. There is about 18.38 percent area of vacant land that has remained in 2011. Vacant land has also been converted into built-up land, tree plantation and wet lands.

All blocks registered negative change in tree plantation except four blocks namely, Jawan, Atrouli, Bijouli and Gangiri. In Chandaus block, it is observed that the area occupied by tree plantation was 3.04 percent in 1996 and 2.11 percent in 2011. It was decreased by 0.93 percent during study periods. Table 3.9 reveals that 50.23 hectares area of tree plantation has been changed into built-up land and 352.34 hectares area has been changed into agricultural land. There is no significant area under water bodies in this block whereas there is no change in wet lands.

## Jawan Block

The built-up land was 2.55 in 1996 and 6.43 percent in 2011. During this period, the built-up land was increased by 3.88 percent while agricultural land was increased by 6.87 percent. The positive change in built-up is due to conversion of agricultural land and vacant land into built-up land. Table 3.11 shows that there is 631.52 hectares agricultural land, 382.38 hectares vacant land and 153.35 hectares tree plantation which have been transformed into built-up land. Agricultural land gained 813.28 hectares area from fallow land, 2100.19 hectares from vacant land, 911.45 hectares from tree plantations and 562.21 hectares from wet lands.

Fallow land decreased from 903.51 hectares ( 3.12 percent) in 1996 to 278.66 hectares ( 0.96 percent) in 2011. It was decreased by 2.16 percent during 1996-2011. It is evident from the table 3.10 that vacant land occupied second place after agricultural land in 1996 whereas it stands fourth position in 2011. As discussed above, vacant land has been decreased due to conversion of vacant land into built-up land and agricultural land. It recorded 3894.22 hectares land (13.44 percent) in 1996 and 1660.21 hectares (5.73 percent) in 2011. It was declined by 7.71 percent during span of fifteen years.

Jawan block registered maximum area under tree plantations after Atrouli block. This block covered 2147.72 hectares ( 7.41 percent) in 1996 and 2220.11 hectares

Table 3.10
Land use/Land Cover of Jawan Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 738.69 | 2.55 | 1861.00 | 6.43 | 3.88 |
| Agricultural Land | 19707.03 | 68.04 | 21697.76 | 74.91 | 6.87 |
| Fallow land | 903.51 | 3.12 | 278.66 | 0.96 | -2.16 |
| Vacant Land | 3894.22 | 13.44 | 1660.21 | 5.73 | -7.71 |
| Tree Plantation | 2147.72 | 7.41 | 2220.14 | 7.66 | 0.25 |
| Water Bodies | 180.18 | 0.62 | 215.92 | 0.75 | 0.13 |
| Wet Lands | 1393.51 | 4.81 | 1031.20 | 3.56 | -1.25 |
| Total | 28964.86 | 100.00 | 28964.86 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.11
Change Matrix Table Jawan Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 693.75 | 2.55 | 0.00 | 17.77 | 24.62 | 0.00 | 0.00 |
| Agri. <br> Land | 631.52 | 17479.89 | 232.08 | 377.53 | 947.72 | 0.00 | 38.32 |
| Fallow <br> land | 0.00 | 831.28 | 46.58 | 0.00 | 25.65 | 0.00 | 0.00 |
| Vacant <br> Land | 382.38 | 2100.19 | 0.00 | 1203.40 | 200.03 | 0.00 | 8.22 |
| Tree <br> Plantation | 153.35 | 911.45 | 0.00 | 61.51 | 827.53 | 26.20 | 167.68 |
| Water <br> Bodies | 0.00 | 10.19 | 0.00 | 0.00 | 25.28 | 113.30 | 31.41 |
| Wet <br> Land | 0.00 | 362.21 | 0.00 | 0.00 | 169.31 | 76.42 | 785.57 |

[^1]

Figure 3.19
Figure 3.20


Figure 3.21


Plate 4. Eucalyptus plantation in row with mustard cultivation in Jawan block


Plate 5. Teak plantation in row with potato cultivation in Jawan block.


Plate 6. Jamun Plantation in Jawan block


Plate 7. Flow of Rettom canal in Jawan block (it is cut from upper ganges canal for irrigation purpose
(7.76 percent) in 2011. During these fifteen years, the total increase in tree plantation was by 0.25 percent.

It is clear from the figure 3.19 and 3.20 that Upper Ganga canal across the middle of the Jawan block. This canal and other water bodies covered 180.18 hectares ( 0.62 percent) which was slightly increased by 0.13 percent during fifteen years. It is observed that there are no more changes in water bodies.

Wet lands are found along the canal and around the water bodies. The total area covered by wet lands was 4.81 percent in 1996 and 3.56 percent in 2011. The decrease in this category is due to transformation of 362.21 hectares wet lands into agricultural lands.

## Lodha Block

Lodha block covered maximum built-up area among all blocks of Aligarh district because it covers a major part of Aligarh city. The proportion of built-up area increased from 2372.77 hectares accounting 7.89 percent to the total geographical area of Lodha block in 1996 to 5896.87 hectares accounting 19.61 percent to the total geographical area of this block in 2011. During 1996-2011, the maximum positive growth under built-up land has been recorded in this block by 11.72 percent. It records maximum positive growth due to rapid growth of urban area of Aligarh city. It is clear from the table 3.12 that built-up area has doubled during fifteen years. It is also obvious from the table 3.13 that there are 1669.76 hectares agricultural land ( 7.69 percent to the total agricultural land of 1996), 1557.53 hectares vacant land ( 33.95 percent of total vacant land in 1996) and 316.89 hectares tree plantations (34 percent area to total tree plantation of 1996) which have been converted into the category of built-up land in 2011.

Table 3.12 shows that agricultural land increased from 2372.77 hectares ( 72.21 percent) in 1996 to 21854.32 .38 hectares (72.67) percent) in 2011. Lodha block witnessed a total increase of 0.46 percent of land under agriculture during 1996 to 2011. It is clear from the table 3.13 that 1669.76 hectares agricultural land has been transformed into built-up land. Other 183.10 hectares agricultural land left as fallow land. Out of total agricultural land of year 1996, 621.68 hectares agricultural land has been converted into

Table 3.12
Land use/Land Cover of Lodha Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | $\mathbf{2 0 1 1}$ |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 2372.77 | 7.89 | 5896.87 | 19.61 | 11.72 |
| Agricultural Land | 21712.96 | 72.21 | 21854.32 | 72.67 | 0.46 |
| Fallow land | 263.43 | 0.88 | 197.75 | 0.66 | -0.22 |
| Vacant Land | 4587.68 | 15.26 | 1349.12 | 4.49 | -10.77 |
| Tree Plantation | 929.21 | 3.09 | 570.51 | 1.90 | -1.19 |
| Water Bodies | 63.46 | 0.21 | 60.52 | 0.20 | -0.01 |
| Wet Lands | 140.93 | 0.47 | 141.35 | 0.47 | 0.00 |
| Total | 30070.44 | 100.00 | 30070.44 | 100.00 | 0.00 |
| Soure Lands 5 | 1996 |  |  |  |  |

Source: Landsat 5 data, 1996 and 2011

Table 3.13
Change Matrix Table of Lodha Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 2352.69 | 5.43 | 0.00 | 1.60 | 13.05 | 0.00 | 0.00 |
| Agri. <br> Land | 1669.76 | 19041.14 | 183.10 | 621.68 | 138.07 | 0.00 | 59.21 |
| Fallow <br> land | 0.00 | 246.78 | 14.65 | 0.00 | 2.00 | 0.00 | 0.00 |
| Vacant <br> Land | 1557.53 | 2280.24 | 0.00 | 679.13 | 63.98 | 0.00 | 6.80 |
| Tree <br> Plantation | 316.89 | 218.06 | 0.00 | 43.29 | 346.40 | 0.00 | 4.57 |
| Water <br> Bodies | 0.00 | 0.00 | 0.00 | 3.42 | 2.61 | 55.90 | 1.53 |
| Wet <br> Land | 0.00 | 62.67 | 0.00 | 0.00 | 4.40 | 4.62 | 69.24 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.22
Figure 3.23


Figure 3.24
vacant land in 2011. This transformation has been observed around the Aligarh city. These transformed vacant lands are plotted for urban settlement. It is seen from the figure 3.24 that the fertile agricultural land has been lost at great level.

The area under fallow land was slight decreased by 0.22 percent during fifteen years. It decreased from 0.88 percent in 1996 to 0.66 percent in 2011.Vacant land comprised 15.26 percent area which was more than the built up land in 1996 where as it constituted only 4.49 percent area which was less than the built-up land in 2011. During 1996-2011, vacant land was decreased by 10.77 percent. It is evident from the table 3.13 that only 1557.53 hectares vacant land has been changed into built-up land which was 33.95 percent of total vacant land in 1996 whereas 2280.24 hectares vacant land has been changed into agricultural land which was 49.70 percent to the total area of vacant land in 1996. It is seen from the figure 3.24 that vacant land around the city has been changed into built-up land while vacant land of other parts of block has been substituted into agricultural lands.

In Lodha block, tree plantation recorded 929.21 hectares (3.09 percent) in 1996 and 570.51 hectares ( 1.90 percent) in 2011. It registered negative change by 1.19 percent during study periods. It is observed from the figure 3.22 and 3.23 that tree plantations are seen in Aligarh city. This area is located in the Aligarh Muslim University area. Such type of land has been decreased due to construction of new buildings, offices, etc. No change has been recorded under water bodies and wet lands. Lodha block registered 63.46 hectares water bodies and 140.93 hectares wet land in 1996 whereas it recorded 60.52 hectares area under water bodies and 141.35 hectares area under wet lands in 2011. In Lodha block, water bodies are seen in the city. These water bodies are ponds and there is no river and canal in this block.

## Dhanipur Block

Dhanipur block recorded maximum positive change in area under built-up land after Lodha block. In this block, the area covered by built-up land was 698.93 hectares ( 2.35 percent) in 1996 and it was 2496.36 hectares ( 8.40 percent) in 2011. During 19962011, it was inclined by 6.05 percent whereas agricultural lands increased from 22133.91

Table 3.14
Land use/Land Cover of Dhanipur Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 698.93 | 2.35 | 2496.36 | 8.40 | 6.05 |
| Agricultural Land | 22133.91 | 74.49 | 23494.28 | 79.06 | 4.58 |
| Fallow land | 441.08 | 1.48 | 174.94 | 0.59 | -0.90 |
| Vacant Land | 3834.66 | 12.90 | 1604.47 | 5.40 | -7.51 |
| Tree Plantation | 1781.91 | 6.00 | 1164.85 | 3.92 | -2.08 |
| Water Bodies | 164.02 | 0.55 | 159.10 | 0.54 | -0.02 |
| Wet Lands | 660.78 | 2.22 | 621.29 | 2.09 | -0.13 |
| Total | 29715.29 | 100.00 | 29715.29 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.15
Change Matrix Table of Dhanipur Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 686.87 | 4.90 | 0.00 | 0.00 | 6.93 | 0.00 | 0.23 |
| Agri. <br> Land | 793.32 | 19956.00 | 153.54 | 615.79 | 591.89 | 0.00 | 23.37 |
| Fallow <br> land | 0.00 | 411.04 | 21.40 | 0.00 | 8.64 | 0.00 | 0.00 |
| Vacant <br> Land | 797.79 | 1847.00 | 0.00 | 973.28 | 143.91 | 14.00 | 58.68 |
| Tree <br> Plantation | 214.92 | 1226.04 | 0.00 | 15.40 | 316.64 | 0.00 | 8.91 |
| Water <br> Bodies | 0.00 | 2.41 | 0.00 | 0.00 | 14.84 | 139.87 | 6.90 |
| Wet <br> Land | 3.46 | 46.89 | 0.00 | 0.00 | 82.00 | 5.23 | 523.20 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.25
Figure 3.26


Figure 3.27
(2.35 percent) in 1996 and it was 2496.36 hectares ( 8.40 percent) in 2011. During 19962011, it was inclined by 6.05 percent whereas agricultural lands increased from 22133.91 hectares ( 74.49 percent) in 1996 to 23114.28 hectares ( 79.06 percent) in 2011, registering a positive growth of 4.58 percent. Fallow land was declined by 0.90 percent during same period. Vacant land was also decreased by 7.51 percent from 1996 to 2011. Vacant land covered 3834.66 hectares ( 12.90 percent) in 1996 and 1604.47 hectares ( 5.40 percent) in 2011.

The highest negative growth under tree plantation has been recorded in Dhanipur block. It registered 1781.91 hectares ( 6.00 percent) in 1996 which declined to 1164.85 hectares ( 3.92 percent) in 2011. The negative change was recorded as 2.08 percent during 1996-2011. The areas under water bodies slightly increased whereas the wet lands slightly decreased.

It is seen from the change matrix table of Dhanipur block that 793.32 hectares agricultural land ( 3.58 percent to total agricultural land in 1996) has been gone into the class of built-up land and 153.54 hectares agricultural land has been converted into fallow land. There are 615.79 hectares agricultural lands which have been changed into vacant land for plotting purposes. Other area of agriculture land i.e. 591.89 hectares and 23.37 hectares have been altered into tree plantations and wet lands respectively. The agricultural land has gained 411.04 hectares area from fallow land, 1847 hectares area from vacant land (48.17 percent to total vacant land of Dhanipur block in 1996). A major portion of agricultural land has been obtained from tree plantations. There are 1226.04 hectares tree plantations ( 68.83 percent of tree plantation in this block in 1996) which have been changed into agricultural land. The agricultural land also earned area from water and wet lands.

Built-up land also obtained area from vacant land and tree plantation. Table 3.15 shows that built-up land also captured 797.79 hectares area from vacant land and 214.02 hectares area from tree plantation. Tree plantation disappeared in the northern and southern part of the block whereas it recorded increase area in the eastern part of the block in 2011. Vacant land of extreme western part of the Dhanipur block has been
changed into built-up land while remaining part of vacant land has been transformed into agricultural land (Figure 3.27). It is observed from the figure 3.25 and 3.26 that wet land and tree plantation appears along the canal.

## Akrabad Block

Built-up land comprised 618.6 hectares ( 2.06 percent to total geographical area of the block) in 1996 and 2132.92 hectares ( 7.09 percent to total geographical area) in 2011. The area under this category was increased by 6.10 percent. In 2011, built-up area attained 1202.49 hectares ( 5.44 percent of agricultural land of Akrabad in 1996) from agricultural land use, 301.73 hectares ( 6.28 percent area of vacant land in 1996) from vacant land and 23.93 hectares (1.72) percent area of tree plantation in 1996) from tree plantation.

The area under agriculture was 22071.79 hectares ( 73.35 percent to total geographical area of the Akrabad block) in 1996 and 23907.61 hectares ( 79.45 percent to total geographical area) in 2011. During fifteen years, the remarkable positive change was observed in this category. It was increased by 6.10 percent. During 1996-2011, agricultural land has been captured 469.72 hectares area ( 97.73 percent to total fallow land area of block in 1996) from fallow land, 2753.56 hectares ( 57.46 percent of vacant land) from vacant land, 655.37 hectares ( 47.29 percent to tree plantation) from tree plantation, 9.97 hectares from water bodies and 119.23 hectares from wet lands.

Fallow land declined from 1.60 percent in 1996 to 0.59 percent in 2011. The area under vacant land was highest in this block in 1996. It covered 4791.7 hectares (15.92 percent) in 1996 which declined to 2002.69 hectares ( 6.66 percent) in 2011. During 19962011, the total area under this category was decreased by 9.27 percent. After Lodha block, the highest negative change in vacant land has been recorded in Akrabad block. It is clearly seen from the figure 3.30 that the conversion of vacant land into agricultural land is more in the south-western part of this block. Vacant land remained in the middle part of the Akrabad block in the year of 2011.

Table 3.16 shows that the area under tree plantation was 1385.65 hectares in 1996

Table 3.16
Land use/Land Cover of Akrabad Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 618.60 | 2.06 | 2132.92 | 7.09 | 5.03 |
| Agricultural Land | 22071.79 | 73.35 | 23907.61 | 79.45 | 6.10 |
| Fallow land | 480.61 | 1.60 | 178.47 | 0.59 | -1.00 |
| Vacant Land | 4791.70 | 15.92 | 2002.69 | 6.66 | -9.27 |
| Tree Plantation | 1385.65 | 4.60 | 1092.02 | 3.63 | -0.98 |
| Water Bodies | 208.09 | 0.69 | 215.80 | 0.72 | 0.03 |
| Wet Lands | 535.40 | 1.78 | 562.33 | 1.87 | 0.09 |
| Total | 30091.84 | 100.00 | 30091.84 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.17
Change Matrix Table of Akrabad Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 604.77 | 3.86 | 0.00 | 0.00 | 9.97 | 0.00 | 0.00 |
| Agri. <br> Land | 1202.49 | 19896.00 | 173.52 | 364.95 | 411.39 | 0.00 | 23.44 |
| Fallow <br> land | 0.00 | 469.72 | 4.95 | 0.00 | 5.94 | 0.00 | 0.00 |
| Vacant <br> Land | 301.73 | 2753.46 | 0.00 | 1622.66 | 47.34 | 11.79 | 54.72 |
| Tree <br> Plantation | 23.93 | 655.37 | 0.00 | 15.08 | 547.27 | 13.41 | 130.59 |
| Water <br> Bodies | 0.00 | 9.97 | 0.00 | 0.00 | 5.31 | 187.32 | 5.49 |
| Wet <br> Land | 0.00 | 119.23 | 0.00 | 0.00 | 64.80 | 3.28 | 348.09 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.28
Figure 3.29


Figure 3.30


Plate 8.
Google earth image show a large number of brick-kilns (13) and stored brick in agricultural land in north-east part of Akrabad block

Plate 9.
A
brick-kiln in
Kauriaganj village


Plate 10.
Brick-making in fertile agricultural
field
that was 4.60 percent and it was registered as 1092.02 hectares in 2011 that was 3.63percent to total geographical area of Akrabad block. The area under tree plantation was declined by 0.98 percent from 1996 to 2011. It is seen from the figure 3.28 that in the year of 1996, the tree plantation is seen in the northern part and along the canal in 1996 and it is disappeared from the middle part of the block in 2011.

Figure 3.30 clears that the area under water bodies increased during one and half decades. There is a pond in between two canal, appeared in the imagery of 2011. The settlement has situated around this water body. From the table 3.16, it is seen that the area under water bodies has increased from 0.69 percent in 1996 to 0.72 percent in 2011 whereas the wet lands has increased from 1.78 percent in 1996 to 1.87 percent in 2011. The change matrix table appears that there are only 3.28 hectares wet lands which have come under the category of water bodies and 119.23 hectares wet lands have changed into the category of agricultural land while wet lands also covered 23.44 hectares area of agricultural land. This area is grown by some specific crops in one season.

## Gonda Block

The total geographical area of the Gonda block is 28771.68 hectares. It covers 7.8 percent area of Aligarh district. It is seen from the table 3.18 that Gonda block has about 92 percent area under agriculture in both the years which is maximum area among all blocks of Aligarh district. Except Tappal and Gonda blocks, all blocks received positive change in agricultural land use. The proportion of agricultural land was 92.84 percent in 1996 which has slight decline to 92.42 percent in 2011. It is clear from the table 3.18 that the area under built-up was 513.39 hectares ( 1.78 percent) in 1996 and it was 1125.97 hectares ( 3.19 percent) in 2011. Gonda registered lowest positive growth i.e. 2.13 percent during 1996-2011. The area under built-up land covered minimum area in this block in the year of 2011. The fallow land increased from 0.39 percent in 1996 to 0.47 percent in 2011.

The area under vacant and tree plantation were lowest in this block in both study years. Vacant land recorded 647.54 hectares ( 2.25 percent) in 1996 and 311.61 hectares (1.08 percent) in 2011 whereas tree plantation covered 582.85 hectares ( 2.03 percent) in

Table 3.18
Land use/Land Cover of Gonda Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 513.39 | 1.78 | 1125.97 | 3.91 | 2.13 |
| Agricultural Land | 26634.94 | 92.57 | 26591.49 | 92.42 | -0.15 |
| Fallow land | 111.76 | 0.39 | 135.89 | 0.47 | 0.08 |
| Vacant Land | 647.54 | 2.25 | 311.61 | 1.08 | -1.17 |
| Tree Plantation | 582.85 | 2.03 | 266.49 | 0.93 | -1.10 |
| Water Bodies | 124.38 | 0.43 | 119.25 | 0.41 | -0.02 |
| Wet Lands | 156.82 | 0.55 | 220.98 | 0.77 | 0.22 |
| Total | 28771.68 | 100.00 | 28771.68 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.19
Change Matrix Table of Gonda Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 509.93 | 0.39 | 0.00 | 1.24 | 1.83 | 0.00 | 0.00 |
| Agri. <br> Land | 473.53 | 25811.06 | 135.89 | 202.60 | 0.17 | 0.00 | 11.69 |
| Fallow <br> land | 0.00 | 110.76 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 |
| Vacant <br> Land | 104.85 | 434.34 | 0.00 | 102.77 | 5.58 | 0.00 | 0.00 |
| Tree <br> Plantation | 37.66 | 184.99 | 0.00 | 5.00 | 243.60 | 0.00 | 111.60 |
| Water <br> Bodies | 0.00 | 11.43 | 0.00 | 0.00 | 3.69 | 98.73 | 10.53 |
| Wet <br> Land | 0.00 | 38.52 | 0.00 | 0.00 | 10.62 | 20.52 | 87.16 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.31
Figure 3.32


Figure 3.33

1996 and 266.49 hectares ( 0.93 percent) in 2011. Vacant land and tree plantation were decreased by 1.17 percent and 1.10 percent respectively during 1996-2011. Figure 3.32 depicts that the area under vacant land and tree plantation almost disappeared in 2011. The area under water bodies in Gonda block was 0.43 percent and 0.41 percent in 1996 and 2011 respectively. Although canal passes in this block but the canal is dried up. There is negligible change in the water bodies. Wet lands increased from 156.82 hectares ( 0.55 percent) in 1996 to 220.98 hectares ( 0.77 percent) in 2011.

The change matrix table of Gonda block is shown in the table 3.19. This table shows that 473.73 hectares agricultural land has been changed into built up area, 135.89 hectares into follow land, 202.60 hectares agricultural land into vacant land, 0.17 hectares into tree plantation and 11.69 hectares into wet lands. On the other hand, agricultural land has been gained area 110.76 hectares area from fallow land, 434.34 hectares area from vacant, 184.99 hectares area from tree plantation, 11.43 hectares area from water bodies and 38.52 hectares area from wet lands. During one and half decades, 104.85 hectares vacant land and 37.66 hectares tree plantation have been transformed into the category of built-up area in 2011.

## Iglas Block

Iglas block is adjacent to Gonda block. It covers smallest area in all blocks of Aligarh district. The total area of Iglas blocks is 23767.88 hectares. After Gonda block, it covers highest percentage area under agriculture. It is seen from the figure 3.35 that Iglas town appears in the middle of the block which has doubled in 2011 as compared to 1996. Table 3.20 shows that the total area under built-up increased from 468.73 hectares (1.97 percent) to 1096.72 hectares ( 4.61 percent) in 2011. It shows that the area under this class was increased by 2.64 percent. Agricultural land was more or less similar area in both study years. It recorded 21486.28 hectares in 1996 and 21712.83 hectares in 2011. It was about 90 percent to total area of block in 1996 and 2011. Fallow land records also negligible changes during 1996-2011. It covered 0.23 percent in 1996 and 0.28 percent in 2011.

Table 3.20
Land use/Land Cover of Iglas Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | $\mathbf{2 0 1 1}$ |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 468.73 | 1.97 | 1096.72 | 4.61 | 2.64 |
| Agricultural Land | 21486.28 | 90.40 | 21712.89 | 91.36 | 0.95 |
| Fallow land | 55.28 | 0.23 | 66.02 | 0.28 | 0.05 |
| Vacant Land | 1175.88 | 4.95 | 528.75 | 2.22 | -2.72 |
| Tree Plantation | 508.49 | 2.14 | 287.59 | 1.21 | -0.93 |
| Water Bodies | 9.04 | 0.04 | 6.61 | 0.03 | -0.01 |
| Wet Lands | 64.18 | 0.27 | 69.00 | 0.29 | 0.02 |
| Total | 23767.88 | 100.00 | 23767.88 | 100.00 | 0.00 |
| Soune: Landsa 5 | 1996 |  |  |  |  |

Source: Landsat 5 data, 1996 and 2011

Table 3.21
Change Matrix Table of Iglas Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 456.23 | 7.80 | 0.00 | 4.70 | 0.00 | 0.00 | 0.00 |
| Agri. <br> Land | 483.32 | 20645.06 | 66.02 | 260.03 | 9.78 | 0.00 | 22.07 |
| Fallow <br> land | 0.00 | 55.28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Vacant <br> Land | 148.95 | 780.93 | 0.00 | 246.00 | 0.00 | 0.00 | 0.00 |
| Tree <br> Plantation | 8.22 | 199.52 | 0.00 | 18.02 | 277.81 | 0.00 | 4.62 |
| Water <br> Bodies | 0.00 | 2.43 | 0.00 | 0.00 | 0.00 | 6.61 | 0.00 |
| Wet <br> Land | 0.00 | 21.87 | 0.00 | 0.00 | 0.00 | 0.00 | 42.31 |

[^2]

Figure 3.34
Figure 3.35


Figure 3.36

The area under vacant land declined from 1175.88 hectares ( 4.95 percent) in 1996 to 528.88 percent in 2011. The area under tree plantation also decreased from 508.49 hectares ( 2.14 percent) in 1996 to 287.59 hectares ( 1.21 percent) in 2011. From 1996 to 2011, the vacant land and tree plantation have decreased by 2.72 percent and 0.93 percent respectively.

Water bodies constituted only 0.04 percent area in 1996 and 0.03 percent in 2011. At the time of winter season, the canal becomes dry so its area appears as wet lands in this season. Wet lands recorded 0.27 percent and 0.29 percent area in 1996 and 2011 respectively.

The change matrix table 3.21 shows that 483.32 hectares agricultural land ( 2.24 percent to total agricultural land of block in 1996), 148.95 hectares vacant land (12.67 percent of vacant land in 1996) and 8.22 hectares tree plantations ( 1.61 percent of tree plantation) have been transformed into built-up land. There are 260.03 hectares agricultural lands which have been changed into vacant land and 22.07 hectares area of agricultural land has been transformed into wet lands. Agricultural land obtained area from other classes of land use. There are 780.93 hectares vacant land ( 66.41 percent of total vacant land in Iglas block in 1996) and 199.52 hectares tree plantation (38.24 percent to total tree plantation in 1996) which have been transformed into agricultural land.

There is only 20.92 percent area of total vacant land of 1996 that remained in 2011 and only 54.53 percent tree plantation area persisted in 2011. Figure 3.35 shows that vacant land appears in the southern part of the block. Tree plantations appear along the main road. This figure also represents that vacant land of northern part has been disappears in 2011.

## Atrouli Block

Atrouli block is located in the north-eastern part of the district and it covers 26316.23 hectares area ( 7.17 percent to total district). The area under built-up land was 623.45 hectares in 1996, pertaining 2.37 percent to total geographical area of Atrouli

Table 3.22
Land use/Land Cover of Atrouli Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 623.45 | 2.37 | 1355.19 | 5.15 | 2.78 |
| Agricultural Land | 20226.05 | 76.86 | 20858.98 | 79.26 | 2.41 |
| Fallow land | 1236.71 | 4.70 | 242.78 | 0.92 | -3.78 |
| Vacant Land | 1927.73 | 7.33 | 962.27 | 3.66 | -3.67 |
| Tree Plantation | 1963.35 | 7.46 | 2473.40 | 9.40 | 1.94 |
| Water Bodies | 92.90 | 0.35 | 90.46 | 0.34 | -0.01 |
| Wet Lands | 246.04 | 0.93 | 333.15 | 1.27 | 0.33 |
| Total | 26316.23 | 100.00 | 26316.23 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.23
Change Matrix Table of Atrouli Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 607.15 | 4.95 | 0.00 | 4.46 | 6.89 | 0.00 | 0.00 |
| Agri. <br> Land | 549.58 | 17582.10 | 205.81 | 474.50 | 1328.33 | 0.00 | 85.73 |
| Fallow <br> land | 0.00 | 1148.35 | 36.97 | 0.00 | 51.39 | 0.00 | 0.00 |
| Vacant <br> Land | 132.57 | 1263.42 | 0.00 | 450.08 | 31.23 | 0.00 | 50.43 |
| Tree <br> Plantation | 65.89 | 784.23 | 0.00 | 33.23 | 993.00 | 0.00 | 87.00 |
| Water <br> Bodies | 0.00 | 0.00 | 0.00 | 0.00 | 2.89 | 82.34 | 7.67 |
| Wet <br> Land | 0.00 | 75.93 | 0.00 | 0.00 | 59.67 | 8.12 | 102.32 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.37
Figure 3.38


Figure 3.39


Plate 11. Mango plantation in Atrouli block

Plate 12.
Guava plantation in Atrouli block


Plate 13. Eucalyptus plantation in Atrouli block
block and it rapidly increased to 1355.19 hectares in 2011, covering 5.15 percent of the total geographical area. It was increased by 2.78 percent during one and half decades.

Atrouli block has 20226.05 hectares agricultural land (76.86 percent) in 1996 and 20858.98 hectares ( 79.26 percent) in 2011. It was gradual increased by 2.41 percent. Table 3.23 shows that out of total agricultural land in 1996, 549.58 hectares ( 2.71 percent), 205.81 hectares ( 1.01 percent), 474.50 hectares ( 2.33 percent), 1328.33 hectares ( 6.53 percent) and 85.73 hectares 0.42 percent) agricultural land have been transformed into built-up land, fallow land, vacant land, tree plantation and wet lands respectively. Agricultural land lost its 13 percent area whereas it achieved 15 percent area during the span of fifteen years. It was increased by only 2.41 percent.

This block received the highest negative change under the area of fallow land. It was 1236.71 hectares ( 4.70 percent) in 1996 and 242.78 hectares ( 0.92 percent) in 2011. The negative change in fallow land experienced as 3.78 percent from 1996 to 2011. There are 1148.35 hectares fallow lands ( 92.86 percent to total fallow land of Atrouli block in 1996) which have been changed into agricultural land into the years of 2011.

Vacant land declined from 1927.73 hectares ( 7.33 percent) in 1996 to 962.27 hectares ( 3.66 percent) in 2011. It was decreased by 3.67 percent during study one and half decades. It is seen from the figure 3.38 that vacant land is remained in the middle part of the block. Out of 1927.73 hectares vacant land in 1996, only 450.08 hectares area remained in 2011. From 1996 to 2011, 475.50 hectares agricultural land and 33.23 hectares tree plantation have been converted into vacant land.

Atrouli block recorded maximum area under tree plantation in all blocks. Guava is famous fruit of Atrouli. Although 59.61 percent areas of tree plantation have been transferred into other classes of land use, Atrouli recorded positive growth in total area of tree plantation. It is clear from the table 3.23 that the area under tree plantation have gained 1388.33 hectares area from agricultural land, 51.39 hectares area from fallow land, 31.22 hectares area from vacant land, 2.89 hectares area from water bodies and 59.67 hectares area from wet lands whereas tree plantation has deducted 65.89 hectares area into built-up land, 784.23 hectares area into agricultural land, 33.23 hectares area
into vacant land and 87 hectares area into wet lands. Figure 3.37 and 3.38 shows that tree plantation are more dominant in the western part of the block in 1996 and 2011. It is also observed that it has been increased on the north-western part of the district in 2011.

The area under water bodies was not so much significant. It covered the extreme east part of the block. It was 0.35 percent in 1996 and 0.34 percent in 2011. Wet lands increased from 246.04 hectares ( 0.93 percent) in 1996 to 333.15 hectares ( 1.27 percent) in 2011. It was increased by 0.33 percent during 1996-2011. This area appears in the eastern part of the district.

## Bijouli Block

Bijouli block covers 25613.53 hectares area of Aligarh district and it is 6.98 percent of district. The Ganga River crosses extreme east part of Bijouli block. The lower Ganga Canal passes this block which is beneficial to agriculture.

The lowest built-up area recorded in Bijouli block in 1996. The built-up land recorded 396.17 hectares ( 1.55 percent) in 1996 and 1489.93 hectares ( 5.82 percent) in 2011. During 1996-2011, the total area under built-up land was increased by 4.27 percent. Bijouli block covered minimum area under agriculture in 1996 and 2011. On the other hand, agricultural land was also increased by 3.73 percent during this period. Table 3.23 shows that the total area was 703.72 hectares which is added to built up area up to 2011 out of which taken area from 262.84 hectares agricultural land ( 1.62 percent of total agricultural land of block in 1996), 89.32 hectares vacant land ( 7.77 percent of vacant land in 1996), 28.76 hectares tree plantation ( 4.06 percent of tree plantation), 312.80 hectares wet lands. Similarly, agricultural land has increased because gained area from 1105.28 hectares fallow land ( 9.64 percent), 614 hectares vacant land ( 5.39 percent of vacant land in 1996), 380 hectares tree plantation ( 5.38 percent of tree plantation ob block in 1996), 608.02 hectares wet lands (13.62 percent of wet lands area of 1996) and 132.93 hectares ( 11.71 percent) from sandy area. Wet lands have been transformed into agricultural land. Figure 3.40 shows that wet lands appears in the eastern part of the block in 1996 whereas it appears as agricultural land in 2011.

Table 3.24
Land use/Land Cover of Bijouli Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 396.17 | 1.55 | 1489.93 | 5.82 | 4.27 |
| Agricultural Land | 16145.73 | 63.04 | 17101.56 | 66.77 | 3.73 |
| Fallow Land | 1147.13 | 4.48 | 430.02 | 1.68 | -2.80 |
| Vacant Land | 1149.49 | 4.49 | 565.87 | 2.21 | -2.28 |
| Tree Plantation | 707.39 | 2.76 | 866.64 | 3.38 | 0.62 |
| Water Bodies | 350.01 | 1.37 | 544.92 | 2.13 | 0.76 |
| Wet Lands | 4582.94 | 17.89 | 2217.08 | 8.66 | -9.23 |
| Sandy Area | 1134.67 | 4.43 | 2397.51 | 9.36 | 4.93 |
| Total | 25613.53 | 100.00 | 25613.53 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.25
Change Matrix Table of Bijouli Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land | Sandy <br> Area |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 384.23 | 9.78 | 0.00 | 0.00 | 2.16 | 0.00 | 0.00 | 0.00 |
| Agri. <br> Land | 262.84 | 14242.10 | 403.74 | 299.61 | 383.58 | 0.00 | 450.63 | 103.23 |
| Fallow <br> land | 0.00 | 1105.28 | 26.28 | 0.00 | 15.57 | 0.00 | 0.00 | 0.00 |
| Vacant <br> Land | 89.32 | 614.00 | 0.00 | 254.26 | 28.35 | 0.00 | 9.30 | 154.26 |
| Tree <br> Plantation | 28.76 | 380.80 | 0.00 | 12.00 | 203.00 | 4.59 | 74.45 | 3.79 |
| Water <br> Bodies | 0.00 | 8.65 | 0.00 | 0.00 | 8.82 | 164.85 | 54.65 | 113.04 |
| Wet <br> Land | 312.80 | 608.02 | 0.00 | 0.00 | 222.28 | 248.76 | 1594.57 | 1196.51 |
| Sandy <br> Area | 11.98 | 132.93 | 0.00 | 0.00 | 2.88 | 126.72 | 33.48 | 826.68 |

[^3]

Figure 3.40
Figure 3.41


Figure 3.42

Mentha is popular crop in this area. Between the Ganga and the lower Ganga canal, there are numerous streams and canals, therefore, wet lands are totally marshy area. The Ganga river has also change course. It is evident from the figure 3.41 that the volume of water is more in 2011 as compared 1996.

Fallow land and vacant land covered almost same proportion in this block. Fallow land covered 1147.13 hectares ( 4.48 percent) in 1996 and 430.02 hectares (1.68 percent) in 2011 whereas vacant land recorded 1149.39 hectares ( 4.49 percent) in 1996 and 565.87 hectares ( 2.21 percent) in 2011. During this one and half decades, fallow land and vacant land were decreased by 2.80 percent and 2.28 percent respectively. Table 3.25 shows that 1105.28 hectares fallow land has been transformed into agricultural land and 15.57 hectares fallow land has been converted into tree plantation. It is seen from the figure 3.41 that those areas which appear as vacant in 1996, it appears as sandy area in 2011. This is due to reflection of land.

The area under tree plantation recorded positive change during study periods. It inclined form 707.39 hectares ( 2.76 percent) in 1996 to 866.64 hectares ( 3.38 percent) in 2011. During this period, it was increased by only 0.62 percent. The area under water bodies and sandy area recorded positive change while wet lands recorded negative change. The reason of decreasing wet lands is conversion of wet lands into agricultural lands. As discussed above, about 17.63 percent area of wet lands have been changed into agriculture and 26.11 percent areas of wet lands have changed into sandy area. Remaining 5.42 percent wet lands have gone into the category of water bodies. This is because of seasonal rainfall. The transformation of land classes can be seen from the figure 3.42.

Water bodies constituted 350.01 hectares (1.37 percent) in 1996 and 544.92 hectares ( 2.13 percent) in 2011. It was increased by 0.76 percent. Wet lands decreased from 4582.94 hectares ( 17.89 percent) in 1996 to 2217.08 hectares ( 8.66 percent) in 2011. It was decreased by 9.23 percent during this period while sandy area increased by 54.93 percent during 1996-2011.

## Gangiri Block

The total area of Gangiri block is 37385.19 hectares which constitutes 10.19 percent of the district. The area under built-up land recorded 781.29 hectares ( 2.09 percent) in 1996 and 1887.60 hectares ( 5.05 percent) in 2011. During 1996-2011, the built-up land was increased by 2.96 percent. Agricultural land increased from 29029.50 hectares ( 77.65 percent) in 1996 to 29762.06 hectares ( 79.61 percent) in 2011. The other classes of land use i.e. fallow land, vacant land and water bodies registered negative change in Gangiri block whereas the area under wet, tree plantation and sandy area marked positive change. The maximum hectares area under fallow land was in Gangiri block. It was 1296.54 hectares ( 3.47 percent) in 1996 and 473.17 hectares ( 1.27 percent) in 2011. Vacant land decreased from 2717.09 hectares ( 7.27 percent) in 1996 to 1294.6 hectares ( 3.46 percent) in 2011. The area under tree plantation and water bodies occupied 4.25 percent and 0.60 percent in 1996 and 4.98 percent and 0.49 percent in 2011 respectively. Fallow land, vacant land and water bodies recorded negative change by 2.20 percent, 3.80 percent and 0.11 percent from1996 to 2011. The area under wet lands has increased from 1689.41 hectares ( 4.52 percent) in 1996 to 1707.65 hectares ( 4.57 percent) in 2011 and sandy area also remarked positive change by 0.42 percent which was 0.15 percent in 1996 and 0.57 percent in 2011.

The change matrix table land use classes of Gangiri block is shown in the table 3.27. It is clear from this table that there are 960.87 hectares agricultural land, 62.97 hectares vacant land, 35.53 hectares tree plantation, 64.91 hectares wet lands and 4.50 hectares sandy area which have been changed into built-up land. There are 9.82 hectares built-up lands, 1251.82 hectares fallow land, 1638.17 hectares vacant land, 659.23 hectares tree plantation, 8.51 hectares water bodies, 295.28 hectares wet lands and 4.14 sandy which have been transformed into agricultural land. There are 445.87 hectares, 399.10 hectares, 988.25 hectares, 306.34 hectares and 33.98 hectares area of agricultural land which have been converted into fallow land, vacant land, tree plantation, wet lands and sandy area respectively. There is 102.75 hectares area of water bodies which have been transformed into wet lands and 79.09 hectares area of wet lands have been

Table 3.26
Land use/Land Cover of Gangiri Block, (1996 and 2011)

| Land Use/ Land <br> Cover Classes | 1996 |  | 2011 |  | Change |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage |  |
| Built-up Land | 781.29 | 2.09 | 1887.60 | 5.05 | 2.96 |
| Agricultural Land | 29029.50 | 77.65 | 29762.06 | 79.61 | 1.96 |
| Fallow Land | 1296.54 | 3.47 | 473.17 | 1.27 | -2.20 |
| Vacant Land | 2717.09 | 7.27 | 1294.60 | 3.46 | -3.80 |
| Tree Plantation | 1589.06 | 4.25 | 1861.49 | 4.98 | 0.73 |
| Water Bodies | 225.63 | 0.60 | 184.92 | 0.49 | -0.11 |
| Wet Lands | 1689.41 | 4.52 | 1707.65 | 4.57 | 0.05 |
| Sandy Area | 56.67 | 0.15 | 213.70 | 0.57 | 0.42 |
| Total | 37385.19 | 100.00 | 37385.19 | 100.00 | 0.00 |

Source: Landsat 5 data, 1996 and 2011

Table 3.27
Change Matrix Table of Gangiri Block (1996-2011)

| Classes | Built-up <br> Land | Agri. <br> Land | Fallow <br> land | Vacant <br> Land | Tree <br> Plantation | Water <br> Bodies | Wet <br> Land | Sandy <br> Area |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Built-up <br> Land | 758.82 | 9.82 | 0.00 | 5.00 | 0.00 | 3.00 | 4.65 | 0.00 |
| Agri. <br> Land | 960.87 | 25895.09 | 445.87 | 399.10 | 988.25 | 0.00 | 306.34 | 33.98 |
| Fallow <br> land | 0.00 | 1251.82 | 27.30 | 0.00 | 17.42 | 0.00 | 0.00 | 0.00 |
| Vacant <br> Land | 62.97 | 1638.17 | 0.00 | 858.95 | 62.00 | 0.00 | 95.00 | 0.00 |
| Tree <br> Plantation | 35.53 | 659.23 | 0.00 | 31.55 | 708.62 | 2.12 | 140.12 | 11.89 |
| Water <br> Bodies | 0.00 | 8.51 | 0.00 | 0.00 | 11.67 | 100.71 | 102.75 | 1.99 |
| Wet <br> Land | 64.91 | 295.28 | 0.00 | 0.00 | 73.53 | 79.09 | 1054.92 | 121.68 |
| Sandy <br> Area | 4.50 | 4.14 | 0.00 | 0.00 | 0.00 | 0.00 | 3.87 | 44.16 |

Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011


Figure 3.43
Figure 3.44


Figure 3.45
converted water bodies. Sandy area obtained area from 121.68 hectares form wet lands and 1.99 hectares area from water bodies.

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## CHAPTER-4

## DYNAㄱMICS OF  USE

Agriculture is the prime activity of human beings and a major source of national economy. It covers about 80 percent area of land in study region. The term "agricultural land use" denotes the extent of the gross cropped area during the agricultural year under various crops (Vaidya, B.C. 1997). It is based on the perception and decision of the farmers. The farmers’ decisions in choice of crops are affected by various factors like demand of crops, price of crops, availability of market, knowledge of farmers, economic condition of farmers etc. Cropping pattern is important tool for determining the agricultural land use. For detailed study of agricultural land use, it is necessary to study the spatial and temporal changes of cropping pattern.

There are two main seasons of crops: - 1) Kharif Season- it starts on the onset of the monsoon in about mid-June. The harvesting period of Kharif season begins at the end of monsoons means September to October. The major Kharif crops are Rice, Millet, Maize and Pulses (Moong, Urad and Arhar) in study area. 2) Rabi Season- the Rabi season starts on receding of monsoon at the end of October or early November. It is generally harvested from mid February to April (sometimes to May). The major Rabi Crops of Aligarh district are Wheat, Barley, Mustard, Potato and Pulses (Masur and Pea). Sugarcane is annual crop which is planted thrice in one year in India.

In this chapter, an attempt is made to analyse cropping pattern of major crops, growth rate in area, production and yield, crop combinations and cropping intensity in Aligarh district.

### 4.1 Cropping Pattern

Cropping pattern may be defined as the spatial arrangement of crops on a particular area to divide the country into homogeneous units using the entities like soil and climate, beside physical and agronomic criteria subdivided on the basis of isotherm lines (Saran et al., 1989). Cropping pattern denotes the proportion of agricultural land use under different crops at a point of time (Tripathi, R.S., 1988). A change in cropping pattern means changes in the proportion under different crops in different periods. It has always been a dynamic concept because of it is a reflection of the interplay of the
complex physical, social, economic and technological factors which change the cropping pattern over space and time. The shift in cropping pattern is very irregular due to the interaction of physical environment on the one hand and the responsible socio-economic factors on the other (Singh and Singh, 1970). The choices of crops are also governed by the choices of the farmers for specific purposes. Cropping pattern is also affected by government policies relating to priorities given to various crops. New technologies, such as use of modern inputs like use of fertilizers, High Yielding Varieties of seeds and irrigation facilities raise the value productivity of crops and changes in cropping patterns (Bajpai and Volavka, 2005).

## a) Spatial Distribution of Major Crops

In this forthcoming discussion, the pattern of crops during the period of 1996-97 and 2011-12 has been tried to discuss. Three categories i.e. High, Medium and Low have been taken for depiction the variation in region under different crops area. The details of crops and their changes during 1996-97 to 2011-12 of whole district are shown in the table 4.1.

Table 4.1
Changes in Cropping Pattern in Aligarh District (1996-97 to 2011-12)

| Crops | $\mathbf{1 9 9 6 - 9 7}$ |  | 2011-12 |  | Changes from 1996-97 <br> to 2011-12 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Hectares | Percentage | Hectares | Percentage | Hectares | Percentage |
| Wheat | 187810 | $\mathbf{3 7 . 7 1}$ | 220707 | $\mathbf{4 0 . 5 1}$ | 32897 | $\mathbf{2 . 8 1}$ |
| Rice | 13404 | $\mathbf{2 . 6 9}$ | 86131 | $\mathbf{1 5 . 8 1}$ | 72727 | $\mathbf{1 3 . 1 2}$ |
| Barley | 25879 | $\mathbf{5 . 2 0}$ | 9603 | $\mathbf{1 . 7 6}$ | -16276 | -3.43 |
| Millet | 76155 | $\mathbf{1 5 . 2 9}$ | 90701 | $\mathbf{1 6 . 6 5}$ | 14546 | $\mathbf{1 . 3 6}$ |
| Maize | 45613 | $\mathbf{9 . 1 6}$ | 17770 | 3.26 | -27843 | $\mathbf{- 5 . 9 0}$ |
| Pulses | 42503 | $\mathbf{8 . 5 3}$ | 16016 | $\mathbf{2 . 9 4}$ | -26487 | $\mathbf{- 5 . 5 9}$ |
| Mustard | 40431 | $\mathbf{8 . 1 2}$ | 17893 | 3.28 | -22538 | $\mathbf{- 4 . 8 3}$ |
| Sugarcane | 12019 | $\mathbf{2 . 4 1}$ | 7334 | $\mathbf{1 . 3 5}$ | -4685 | $\mathbf{- 1 . 0 7}$ |
| Potato | 4274 | $\mathbf{0 . 8 6}$ | 23861 | $\mathbf{4 . 3 8}$ | 19587 | $\mathbf{3 . 5 2}$ |
| Others | 50014 | $\mathbf{1 0 . 0 4}$ | 54767 | $\mathbf{1 0 . 0 5}$ | 4753 | $\mathbf{0 . 0 1}$ |
| Total | 498102 | $\mathbf{1 0 0 . 0 0}$ | 544783 | $\mathbf{1 0 0 . 0 0}$ | 46681 | $\mathbf{0 . 0 0}$ |

Source: Directorate of Agriculture Statistics, Aligarh, 1998 and 2013

## Cropping Pattern in Aligarh District（1996－97）



日Wheat


■Barley
©Millet
$\square$ Maize
■Pulses
－Mustard
© Sugarcane
OPotato
■Others

Figure 4.1

## Cropping Pattern in Aligarh District（2011－12）



| 日Wheat |
| :---: |
| 田Rice |
| ■Barley |
| －Millet |
| $\square$ Maize |
| mPulses |
| －Mustard |
| $\bullet$ Sugarcane |
| 图Potato |
| －Others |

Figure 4.2

Wheat- Wheat is first rank crop in study area and is the main dietary food of the people of the study region. It increased from 187810 hectares ( 37.71 percent) in 1996-97 to 220707 hectares ( 40.51 percent) in 2011-12 in Aligarh district. During this period it increased by only 2.81 percent

The spatial distribution of wheat is shown in figure 4.4 for the year 1996-97. This figure depicts that higher area under wheat is distributed in Tappal ( 46.88 percent), Gonda ( 41.21 percent) and Khair ( 41.16 percent) blocks. Between 35.71 percent and 39.67 percent area has been observed in Chandaus, Iglas and Bijouli. Low area under wheat (below 35.71 percent) has been recorded in six blocks, namely, Jawan, Lodha, Dhanipur, Akrabad, Atrouli and Gangiri.

In 2011, the highest area under wheat has been found in Tappal block (45.38 percent) followed by Akrabad ( 44.10 percent) whereas lowest area has been observed in Iglas ( 27.79 percent) followed by Lodha ( 37.89 percent). The medium category of wheat (38.11-42.61 percent) area has been found in eight blocks, namely, Khair, Chandaus, Jawan, Dhanipur, Gonda, Atrouli, Bijouli and Gangiri.


Figure 4.3

Rice- Table 4.1 shows that the total area under rice was 13404 hectares ( 2.69 percent to total gross cropped area) in the year 1996-97 whereas it increased to 86131 hectares ( 15.81 percent) in 2011-12. This table indicates that rice has been recorded tremendous increase out of all crops by 13.12 percent during this period. The area under rice varies from block to block in Aligarh district. The spatial pattern of rice in the year of 1996-97 is shown in figure 4.6. This figure shows that three blocks namely Jawan, Dhanipur, Akrabad have high area (above 4.04 percent) under rice whereas four blocks namely, Chandaus, Lodha, Iglas and Gangiri have low area of rice (below 1.25 percent). There are other five blocks namely, Tappal, Atrouli, Bijouli, Khair and Gonda which show the medium category of rice area. Figure 4.7 shows that in the year of 2011-12, four blocks namely, Jawan, Dhanipur, Akrabad and Chandaus record high area under rice above 20.65 percent. Another four blocks (Tappal, Khair, Gonda and Atrouli) fall under medium category between 11.05 percent and 20.65 percent and remaining four blocks i.e. Lodha, Iglas, Gangiri and Bijouli come under the low category of rice area.

Barley- It is a coarse cereal crop. Table 4.1 shows that the area under barley is 25879 hectares ( 5.20 percent) in 1996-97 and 9603 hectares (1.76 percent) in 2011-12 at a decreasing rate of about 3 percent during fifteen years. The yield of barley is low as compared to wheat so the farmers are not interested in growing this crop.

In the year of 1996-97, the maximum area under this category has been noticed in Khair, Atrouli, Bijouli, and Gangiri blocks which account more than 5.65 percent area of the gross cropped area. There are three blocks, namely, Chandaus, Lodha and Gonda which has been recorded between 4.76 percent and 5.65 percent area under barley. The low area under barley (below 4.76 percent) has been observed in five blocks i.e. Tappal, Jawan, Dhanipur, Akrabad, and Iglas.

The spatial distribution of barley in 2011-12 depicts in figure 4.9. This figure shows that eastern part of the region is noticed high area under barley out of which Gangiri block cover maximum area under barley with 3.78 percent area. There are four blocks, namely, Khair, Chandaus, Jawan, and Lodha fall under medium category ranging

Table 4.2
Block-wise Cropping Pattern of Wheat, Rice and Barley (1996-97 and 2011-12)

| Blocks | Wheat |  |  |  | Rice |  |  |  | Barley |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1996-97 |  | 2011-12 |  | 1996-97 |  | 2011-12 |  | 1996-97 |  | 2011-12 |  |
|  | Hectares | \% | Hectares | \% | Hectares | \% | Hectares | \% | Hectares | \% | Hectares | \% |
| Tappal | 22245 | 46.88 | 25927 | 45.38 | 1885 | 3.97 | 6703 | 11.73 | 1962 | 4.13 | 632 | 1.11 |
| Khair | 17388 | 41.16 | 20137 | 41.06 | 546 | 1.29 | 7282 | 14.85 | 2703 | 6.4 | 761 | 1.55 |
| Chandaus | 17385 | 39.39 | 20700 | 41.74 | 434 | 0.98 | 10322 | 20.81 | 2323 | 5.26 | 793 | 1.6 |
| Jawan | 14112 | 35.01 | 18269 | 42.11 | 1853 | 4.6 | 11250 | 25.93 | 1665 | 4.13 | 722 | 1.66 |
| Lodha | 12570 | 34.74 | 14519 | 37.89 | 175 | 0.48 | 3547 | 9.26 | 1906 | 5.27 | 790 | 2.06 |
| Dhanipur | 13791 | 32.86 | 16807 | 42.05 | 1920 | 4.57 | 12187 | 30.49 | 1854 | 4.42 | 473 | 1.18 |
| Akrabad | 14667 | 34.52 | 18443 | 44.1 | 4259 | 10.02 | 12574 | 30.07 | 1872 | 4.41 | 498 | 1.19 |
| Gonda | 15355 | 41.21 | 17393 | 38.12 | 549 | 1.47 | 8691 | 19.05 | 2015 | 5.41 | 595 | 1.3 |
| Iglas | 13442 | 38.21 | 10690 | 27.79 | 107 | 0.3 | 3911 | 10.17 | 1552 | 4.41 | 316 | 0.82 |
| Atrouli | 15392 | 35.32 | 17253 | 40.16 | 844 | 1.94 | 5550 | 12.92 | 2841 | 6.52 | 952 | 2.22 |
| Bijouli | 13370 | 37.55 | 14545 | 42.6 | 580 | 1.63 | 960 | 2.81 | 2213 | 6.21 | 906 | 2.65 |
| Gangiri | 17787 | 35.42 | 21246 | 41.3 | 246 | 0.49 | 1090 | 2.12 | 2954 | 5.88 | 1943 | 3.78 |

Source: Directorate of Agriculture Statistics, Aligarh

Table 4.3
Categories of Area under Wheat in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of <br> Blocks | Name of Blocks | Value | No. of <br> Blocks | Name of Blocks |
| High | Above <br> 39.67 | 3 | Tappal, Khair, Gonda | Above <br> 42.61 | 2 | Tappal, Akrabad |
| Medium | 35.71 <br> to <br> 39.67 | 3 | Chandaus, Iglas, <br> Bijouli | 38.11 <br> to <br> 42.61 | 8 | Khair, Chandaus, Jawan, <br> Dhanipur, Gonda, <br> Atrouli, Bijouli, Gangiri |
| Low | Below <br> 35.71 | 6 | Jawan, Lodha, <br> Dhanipur, Akrabad, <br> Atrouli, Gangiri | Below <br> 38.11 | 2 | Lodha, Iglas |

Source: Computed by Researcher based on table 4.2

Table 4.4
Categories of Area under Rice in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of <br> Blocks | Name of Blocks | Value | No. of <br> Blocks | Name of Blocks |
| High | Above <br> N.04 | 3 | Jawan, Dhanipur, <br> Akrabad | Above <br> 20.65 | 4 | Jawan, Lodha, <br> Dhanipur, Akrabad |
| Medium | 1.25 to <br> 4.04 | 5 | Tappal, Khair, Gonda, <br> Atrouli, Bijouli | 11.05 to <br> 20.65 | 4 | Tappal, Khair, <br> Gonda, Atrouli |
| Low | Below <br> 1.25 | 4 | Chandaus, Lodha, <br> Iglas, Gangiri | Below <br> 11.05 | 4 | Lodha, Iglas, <br> Bijouli, Gangiri |

Source: Computed by Researcher based on table 4.2

Table 4.5
Categories of Area under Barley in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of <br> Blocks | Name of Blocks | Value | No. of <br> Blocks | Name of Blocks |
| High | Above <br> 5.65 | 4 | Khair, Atrouli, <br> Bijouli, Gangiri | Above <br> 2.17 | 3 | Atrouli, Bijouli, Gangiri |
| Medium | 4.76 to <br> 5.65 | 3 | Chandaus, Lodha, <br> Gonda | 1.35 to <br> 2.17 | 4 | Khair, Chandaus, Jawan, <br> Lodha |
| Low | Below <br> 4.76 | 5 | Tappal, Jawan, <br> Dhanipur, Akrabad, <br> Iglas | Below <br> 1.35 | 5 | Tappal, Dhanipur, <br> Akrabad, Gonda, Iglas |

Source: Computed by Researcher based on table 4.2


Figure 4.4


Figure 4.5


Figure 4.6


Figure 4.7


Figure 4.8


Figure 4.9
1.35 percent to 2.17 percent whereas five blocks (Tappal, Dhanipur, Akrabad, Gonda and Iglas ) come under the category of low area below 1.35 percent.

Millet- Millet is coarse cereal crop and stands second leading crop in study region. India ranks first in production of millet. It is used for food, brewing in millet bear, used as bird and animal food and its straw is also used as valuable food for the milk animals. Pearl millet is important variety of millet which is commonly grown in study area. It is short time period crop and requires little irrigation. It can be grown as dry crops. The area under millet has been marginally increased from 76155 hectares (15.29 percent) in 199697 to 90701 hectares ( 16.65 percent) in 2011-12. The increase in area under millet has been measured as 14546 hectares or 1.36 percent during the period of 1996-97 to 201112.

Table 4.2 shows that during 1996-97 to 2011-12 there is no much more changes under millet area. Figure 4.10 shows that in the year of 1996-97, the high area under millet above 18.12 percent has been found in Lodha, Gonda, Iglas, Bijouli and Gangiri. There are only three blocks namely Khair, Chandaus and Atrouli which have area of medium category range between 12.78 percent and 18.12 percent. The low category of millet has been noticed in Jawan ( 8.02 percent), Dhanipur ( 9.25 percent), Akrabad (9.92 percent) and Tappal (10.18 percent). In the year of 2011-12, two blocks (Gonda and Iglas) are added to the high category above 20.50 percent. There are four blocks namely, Chandaus, Gonda, Iglas and Atrouli which fall under medium category range between 13.70 percent and 20.50 percent. Only one block i.e. Khair is added with the low category of millet in 2011-12.

Maize- Maize is known as corn in India and it is also one of the staple foods of the people of the study region. It is also used as food for livestock like millet. It is important cereal crops because the riping time of maize is short. The area under this category was 45613 hectares ( 9.16 percent) in 1996-97 which reduced to 17770 hectares ( 3.26 percent) in 2011-12, thus a net decrease of 27843 hectares ( 5.90 percent). The reason for decrease of maize is low yield and low price than wheat and rice

The distributional pattern of maize shows that eastern part of the region constituting five blocks have high area in 1996-97 while Dhanipur is subtracted from high category area of maize in 2011-12. The western part of the region having five blocks shows low area under maize in 1996-97 and Chandaus block is added to this category in 2011-12. During 1996-97 and 2011-12, the medium category of maize constitutes two blocks, out of them Akrabad has medium area under maize in both years whereas Chandaus in former and Dhanipur in latter year.

Pulses- The total area under pulses was 42503 hectares ( 8.53 percent) in 1996-97 which came down as 16016 hectares ( 2.94 percent) in 2011-12 by marking decrease of 5.59 percent during 1996-2011. The main cause behind it is low yield, susceptible to diseases, lack of High Yielding Varieties of seeds and damage by wild animals. It is also highly sensitive crops from frost, fog and rainfall. At the time of flowering of pulses if heavy rainfall occurs, it damage the flowers of the crops.

The spatial distribution of maize has been plotted in figure 4.14 for 1996-97 and 2011-12. This figure shows that high category area of pulses are concentrated in the central part of the district including Jawan, Lodha, Dhanipur and Akrabad in 1996-97 while it is high in Chandaus, Jawan, Lodha, and Dhanipur in 2011-12. Akrabad records highest decreases area in pulses about 10 percent during 1996-97 to 2011-12. Four villages fall under the medium category of pulses in both years. They are Khair, Chandaus, Atrouli and Gangiri in 1996-97 whereas Khair, Akrabad, Iglas and Atrouli in 2011-12. The low area below 7.21 percent has been observed in Tappal, Gonda, Iglas and Bijouli in 1996-97 whereas low area below 2.45 percent area has been seen in Tappal, Gonda, Bijouli and Gangiri in 2011-12.

Mustard- Mustard is dominant crop of oilseeds. Out of total oilseeds, mustard occupies about 99 percent area. It was 40431 hectares area constituting 8.12 percent to total gross cropped area in 1996-97 while it was 17893 hectares pertaining 3.28 percent to total gross cropped area in 2011-12. Therefore, it was decreased by 4.83 percent during fifteen years.

During the period 1996-97, the high area under mustard has been concentrated in

Table 4.6
Block-wise Cropping Pattern of Millet, Maize and Pulses (1996-97 and 2011-12)

| Blocks | Millet |  |  |  | Maize |  |  |  | Pulses |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1996-97 |  | 2011-12 |  | 1996-97 |  | 2011-12 |  | 1996-97 |  | 2011-12 |  |
|  | Hectares | \%age | Hectares | \%age | Hectares | \%age | Hectares | \%age | Hectares | \%age | Hectares | \%age |
| Tappal | 4831 | 10.18 | 5184 | 9.07 | 2441 | 5.14 | 517 | 0.9 | 2806 | 5.91 | 1316 | 2.30 |
| Khair | 6259 | 14.81 | 5766 | 11.76 | 1925 | 4.56 | 333 | 0.68 | 3334 | 7.89 | 1240 | 2.53 |
| Chandaus | 5966 | 13.52 | 8007 | 16.15 | 3851 | 8.73 | 602 | 1.21 | 3886 | 8.81 | 1745 | 3.52 |
| Jawan | 3233 | 8.02 | 3506 | 8.08 | 5938 | 14.73 | 2866 | 6.61 | 4105 | 10.18 | 1659 | 3.82 |
| Lodha | 6819 | 18.85 | 9025 | 23.55 | 1956 | 5.41 | 584 | 1.52 | 3550 | 9.81 | 1371 | 3.58 |
| Dhanipur | 3883 | 9.25 | 5152 | 12.89 | 5097 | 12.14 | 877 | 2.19 | 4995 | 11.90 | 2003 | 5.01 |
| Akrabad | 4215 | 9.92 | 5401 | 12.91 | 4088 | 9.62 | 938 | 2.24 | 5852 | 13.77 | 1367 | 3.27 |
| Gonda | 7329 | 19.67 | 8913 | 19.54 | 553 | 1.48 | 105 | 0.23 | 2534 | 6.80 | 677 | 1.48 |
| Iglas | 7663 | 21.78 | 7634 | 19.84 | 394 | 1.12 | 89 | 0.23 | 2336 | 6.64 | 1014 | 2.64 |
| Atrouli | 6798 | 15.6 | 6686 | 15.56 | 6883 | 15.79 | 4048 | 9.42 | 3186 | 7.31 | 1179 | 2.74 |
| Bijouli | 7243 | 20.34 | 8958 | 26.24 | 5490 | 15.42 | 2216 | 6.49 | 1630 | 4.58 | 656 | 1.92 |
| Gangiri | 11795 | 23.49 | 15238 | 29.62 | 6881 | 13.7 | 3919 | 7.62 | 4272 | 8.51 | 1192 | 2.32 |

Source: Directorate of Agriculture Statistics, Aligarh

Table 4.7
Categories of Area under Millet in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of <br> Blocks | Name of Blocks | Value | No. of <br> Blocks | Name of Blocks |
| High | Above <br> 18.12 | 5 | Lodha, Gonda, <br> Iglas, Bijouli, <br> Gangiri | Above <br> 20.50 | 3 | Lodha, Bijouli, <br> Gangiri |
| Medium | 12.78 to <br> 18.12 | 3 | Khair, Chandaus, <br> Atrouli | 13.70 to <br> 20.50 | 4 | Chandaus, Gonda, <br> Iglas, Atrouli |
| Low | Below <br> 12.78 | 4 | Tappal, Jawan, <br> Dhanipur, Akrabad | Below <br> 13.70 | 5 | Tappal, Khair, Jawan, <br> Dhanipur, Akrabad |

Source: Computed by Researcher based on table 4.6

Table 4.8
Categories of Area under Maize in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of <br> Blocks | Name of Blocks | Value | No. of <br> Blocks | Name of Blocks |
| High | Above <br> 11.68 | 5 | Jawan, Dhanipur, <br> Atrouli, Bijouli, <br> Gangiri | Above <br> 4.92 | 4 | Jawan, Atrouli, <br> Bijouli, Gangiri |
| Medium | 6.30 to <br> 11.68 | 2 | Chandaus, Akrabad | 1.64 to <br> 4.92 | 2 | Dhanipur, Akrabad |
| Low | Below <br> 6.30 | 5 | Tappal, Khair, <br> Dhanipur, Gonda, <br> Iglas | Below <br> 1.64 | 6 | Tappal, Khair, <br> Chandaus, Dhanipur, <br> Gonda, Iglas |

Source: Computed by Researcher based on table 4.6

Table 4.9
Categories of Area under Pulses in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of Blocks | Name of Blocks | Value | No. of Blocks | Name of Blocks |
| High | Above $9.81$ | 4 | Jawan, Lodha, Dhanipur, Akrabad | Above $3.41$ | 4 | Chandaus, Jawan, Lodha, Dhanipur |
| Medium | $\begin{gathered} 7.21 \text { to } \\ 9.81 \end{gathered}$ | 4 | Khair, Chandaus, Atrouli, Gangiri | $\begin{gathered} 2.45 \text { to } \\ 3.41 \end{gathered}$ | 4 | Khair, Akrabad, Iglas, Atrouli |
| Low | $\begin{gathered} \text { Below } \\ 7.21 \end{gathered}$ | 4 | Tappal, Gonda, Iglas, Bijouli | $\begin{gathered} \text { Below } \\ 2.45 \end{gathered}$ | 4 | Tappal, Gonda, Bijouli, Gangiri |

Source: Computed by Researcher based on table 4.6


Figure 4.10


Figure 4.11


Figure 4.12


Figure 4.13


Figure 4.14


Figure 4.15
south-western part of the district include four blocks, namely, Khair, Lodha, Gonda and Iglas having value above 9.56 percent. During the period 2011-12, the pattern of mustard area has been changed. Figure 4.17 shows that five blocks, namely, Tappal, Khair, Chandaus, Lodha, and Atrouli, record high proportion of area under mustard having value above only 3.75 percent. The medium category of mustard occupies Chandaus ( 9.21 percent), Tappal, ( 8.39 percent) and Dhanipur ( 8.07 percent) in 1996-97 whereas this category of mustard observes in Jawan (3.17 percent), Dhanipur ( 2.86 percent), Akrabad ( 2.83 percent) and Bijouli (2.75 percent) in 2011-12. The eastern part of Aligarh district (Jawan, Akrabad, Atrouli, Bijouli, and Gangiri) cover low area of mustard while this pattern of low area has been changed in 2011-12. The low area under mustard concentrates in different location (Gonda, Iglas and Gangiri) in 2011-12.

Sugarcane- It is evident from the table 4.12 that each block has below 6 percent area in 1996 and below 3 percent area in 2011-12. This shows low proportion of area under sugarcane. Jawan has maximum area under sugarcane i.e. 6.06 percent followed by Tappal block (4.23 percent) in 1996-97. Figure 4.16 shows that out of 12 blocks, seven blocks register medium category area range between 1.65 percent and 3.12 percent in 1996-97. They are Khair, Chandaus, Dhanipur, Akrabad, Atrouli, Bijouli and Gangiri. Remaining three blocks (Lodha, Gonda and Iglas) have low area under this cash crop below 1.65 percent in 1996-97. There are three blocks namely Khair, Akrabad and Gangiri which fall under the medium category while five blocks, namely, Lodha, Dhanipur, Gonda, Iglas and Atrouli reports low area under sugarcane below 0.74 percent area in 2011-12.

Potato- It is evergreen crop because of high demand throughout the year. Therefore, farmers have to attract for this cash crop. This is the reason for tremendous increasing area under potato cultivation It is clearly seen from the table 4.10 that the area under potato increased from 4274 hectares ( 0.86 percent) in 1996-97 to 23861 hectares ( 4.38 percent) in 2011-12 which records second position in growth after rice increased by 3.52 percent during the study periods.

There is variation within district regarding this cash crop. It is seen from the table 4.13 that the highest area under potato has been observed in Iglas ( 2.93 percent) followed

Table 4.10
Block-wise Cropping Pattern of Mustard, Sugarcane and Potato (1996-97 and 2011-12)

| Blocks | Mustard |  |  |  | Sugarcane |  |  |  | Potato |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1996-97 |  | 2011-12 |  | 1996-97 |  | 2011-12 |  | 1996-97 |  | 2011-12 |  |
|  | Hectares | \%age | Hectares | \%age | Hectares | \%age | Hectares | \%age | Hectares | \%age | Hectares | \%age |
| Tappal | 3980 | 8.39 | 2238 | 3.92 | 2008 | 4.23 | 1636 | 2.86 | 151 | 0.32 | 794 | 1.39 |
| Khair | 4651 | 11.01 | 2143 | 4.37 | 766 | 1.81 | 695 | 1.42 | 359 | 0.85 | 1934 | 3.94 |
| Chandaus | 4064 | 9.21 | 2324 | 4.69 | 934 | 2.12 | 1039 | 2.10 | 206 | 0.47 | 951 | 1.92 |
| Jawan | 2492 | 6.18 | 1377 | 3.17 | 2442 | 6.06 | 1174 | 2.71 | 204 | 0.51 | 380 | 0.88 |
| Lodha | 4143 | 11.45 | 1741 | 4.54 | 270 | 0.75 | 147 | 0.38 | 163 | 0.45 | 2032 | 5.30 |
| Dhanipur | 3386 | 8.07 | 1142 | 2.86 | 1016 | 2.42 | 297 | 0.74 | 501 | 1.19 | 995 | 2.49 |
| Akrabad | 2504 | 5.89 | 1185 | 2.83 | 975 | 2.29 | 339 | 0.81 | 194 | 0.46 | 464 | 1.11 |
| Gonda | 3911 | 10.50 | 885 | 1.94 | 508 | 1.36 | 18 | 0.04 | 572 | 1.54 | 5266 | 11.54 |
| Iglas | 4302 | 12.23 | 612 | 1.59 | 365 | 1.04 | 8 | 0.02 | 1030 | 2.93 | 8781 | 22.83 |
| Atrouli | 2655 | 6.09 | 1619 | 3.77 | 838 | 1.92 | 266 | 0.62 | 387 | 0.89 | 580 | 1.35 |
| Bijouli | 1589 | 4.46 | 938 | 2.75 | 1050 | 2.95 | 961 | 2.81 | 143 | 0.40 | 363 | 1.06 |
| Gangiri | 2682 | 5.34 | 1314 | 2.55 | 846 | 1.68 | 676 | 1.31 | 278 | 0.55 | 489 | 0.95 |

Source: Directorate of Agriculture Statistics, Aligarh

Table 4.11
Categories of Area under Mustard in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of <br> Blocks | Name of Blocks | Value | No. of <br> Blocks | Name of Blocks |
| High | Above <br> 9.56 | 4 | Khair, Lodha, <br> Gonda, Iglas | Above <br> 3.75 | 5 | Tappal, Khair, <br> Chandaus, Lodha, <br> Atrouli |
| Medium | 6.91 to <br> 9.56 | 3 | Tappal, Chandaus, <br> Dhanipur | 2.74 to <br> 3.75 | 4 | Jawan, Dhanipur, <br> Akrabad |
| Low | Below <br> 6.91 | 5 | Jawan, Akrabad, <br> Atrouli, Bijoul, <br> Gangiri | Below <br> 2.74 | 3 | Gonda, Iglas, Gangiri |

Source: Computed by Researcher based on table 4.10
Table 4.12
Categories of Area under Sugarcane in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of Blocks | Name of Blocks | Value | No. of Blocks | Name of Blocks |
| High | Above <br> 3.12 | 2 | Tappal, Jawan | Above 1.85 | 4 | Tappal, Chandaus, Jawan |
| Medium | $\begin{gathered} 1.65 \text { to } \\ 3.12 \end{gathered}$ | 7 | Khair, Chandaus, Dhanipur, Akrabad, Atrouli, Bijouli, Gangiri | $\begin{gathered} 0.79 \text { to } \\ 1.85 \end{gathered}$ | 3 | Khair, Akrabad, Gangiri |
| Low | $\begin{gathered} \text { Below } \\ 1.65 \end{gathered}$ | 3 | Lodha, Gonda, Iglas | $\begin{gathered} \text { Below } \\ 0.79 \end{gathered}$ | 5 | Lodha, Dhanipur, Gonda, Atrouli |

Source: Computed by Researcher based on table 4.10
Table 4.13
Categories of Area under Potato in Aligarh District (1996-97 and 2011-12)

| Categories | 1996 |  |  | 2011 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Value | No. of <br> Blocks | Name of Blocks | Value | No. of <br> Blocks | Name of Blocks |
| High | Above <br> 1.25 | 2 | Gonda, Iglas | Above <br> 7.82 | 2 | Gonda, Iglas |
| Medium | 0.51 to <br> 1.25 | 4 | Khair, Dhanipur, <br> Atrouli, Gangiri | 1.31 to <br> 7.82 | 6 | Tappal, Khair, Chandaus, <br> Lodha, Dhanipur, Atrouli |
| Low | Below <br> 0.51 | 6 | Tappal, Chandaus, <br> Jawan, Lodha, <br> Akrabad, Bijouli | Below <br> 1.31 | 4 | Jawan, Akrabad, Bijouli, <br> Gangiri |

[^4]

Figure 4.16


Figure 4.17


Figure 4.18


Figure 4.19


Figure 4.20


Figure 4.21
by Gonda (11.54) in both periods. Gonda and Iglas are high in cultivation of potato due to sufficient availability of cold storages and soil is also suitable for this cash crop cultivation. The medium category of potato area has been recorded in Khair, Dhanipur, Atrouli and Gangiri ranging between 0.51 percent and 1.25 percent whereas six blocks, namely, Tappal, Chandaus, Jawan, Lodha, Akrabad and Bijouli come under the category of low having below 0.51 percent area in the year of 1996-97. The position of medium and low category has been changed in the year of 2011-12. The medium category is replaced by seven blocks i.e. Tappal, Khair, Chandaus, Lodha, Dhanipur, and Atrouli whereas low area under potato has been recorded in Jawan, Akrabad, Bijouli and Gangiri.

Others- Others include cotton and fodder. Cotton constitutes only 0.64 percent to total gross cropped area. It is not significant so it has not been taken. Fodder includes Rabi, Kharif and Zaid fodder which are cultivated for feeding the animals. Total fodder covers about seven to eight percent area in district.

## b) Trend in Area, Production and Yield in Aligarh District (1996-97 to 2011-12)

The grown rate in area, production and yield of major crops in Aligarh district are given in Table 4.1 for three quinquenial periods i.e. 1996-01, 2001-06 and 2006-11. The trend of area and production of major cereals (Rice, Wheat, Barley, Millet and Maize), pulses (Urad, Moong, Masoor, Arhar, Gram, and Pea) oilseeds (Mustard), and major cash crops (Sugarcane, Potato and Cotton) are plotted in figure 4.22, 4.23, 4.24 and 4.25 respectively.

Wheat: The area under wheat shows an increasing trend in all study periods. It occupied an area of 187810 hectares in 1996-97 which increased to 213864 hectares in 2001-02. The area again reached to 219466 hectares in 2006-07 and further increased to 220707 hectares in 2011-12. While the production shows a fluctuation. In the year of 1996-97, the production of wheat was 602575 metric tonnes which increased to 700120 metric tonnes in 2001-02. It decreased to 626981 metric tonnes in the year 2006-07 but it again rose to 830185 metric tonnes in 2011-12. The average yield of wheat rose up from 32.08 quintal per hectare in 1996-97 to 33.09 quintal per hectare in 2001-02. It declined to 28.57 quintal per hectare and again decreased in 2011-12 i.e. 37.61 percent.

Table 4.14
Area under Major Crops in Aligarh District
(Area in hectares)

| Crops | Years |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | $\mathbf{1 9 9 6 - 9 7}$ | $\mathbf{2 0 0 1 - 0 2}$ | $\mathbf{2 0 0 6} \mathbf{- 0 7}$ | $\mathbf{2 0 1 1 - 1 2}$ |
| Rice | 13404 | 33654 | 47676 | 86131 |
|  | $(2.69)$ | $(6.66)$ | $(9.23)$ | $(15.81)$ |
| Wheat | 187810 | 213864 | 219466 | 220707 |
|  | $(37.71)$ | $(42.35)$ | $(42.48)$ | $(40.51)$ |
| Barley | 25879 | 21788 | 14658 | 9603 |
|  | $(5.20)$ | $(4.31)$ | $(2.84)$ | $(1.76)$ |
| Millet | 76155 | 82749 | 85974 | 90701 |
|  | $(15.29)$ | $(16.39)$ | $(16.64)$ | $(16.65)$ |
| Maize | 45613 | 44048 | 26820 | 17770 |
|  | $(9.16)$ | $(8.72)$ | $(5.19)$ | $(3.26)$ |
| Urad | 648 | 690 | 654 | 663 |
|  | $(0.13)$ | $(0.14)$ | $(0.13)$ | $(0.12)$ |
| Moong | 12103 | 4759 | 3481 | 3912 |
|  | $(2.43)$ | $(0.94)$ | $(0.67)$ | $(0.72)$ |
| Masur | 1752 | 2251 | 1851 | 1195 |
|  | $(0.35)$ | $(0.45)$ | $(0.36)$ | $(0.22)$ |
| Gram | 3547 | 1071 | 147 | 21 |
|  | $(0.71)$ | $(0.21)$ | $(0.03)$ | $(0.00)$ |
| Pea | 3673 | 1595 | 303 | 131 |
|  | $(0.74)$ | $(0.32)$ | $(0.06)$ | $(0.02)$ |
| Arhar | 20771 | 17338 | 15741 | 10094 |
|  | $(4.17)$ | $(3.43)$ | $(3.05)$ | $(1.85)$ |
| Mustard | 40431 | 16531 | 21914 | 17893 |
|  | $(8.12)$ | $(3.27)$ | $(4.24)$ | $(3.28)$ |
|  | 12019 | 9109 | 9653 | 7334 |
| Potato | $(2.41)$ | $(1.80)$ | $(1.87)$ | $(1.35)$ |
|  | 4274 | 6059 | 13642 | 23861 |
|  | $(0.86)$ | $(1.20)$ | $(2.64)$ | $(4.38)$ |

Note: Figures given within the brackets shows percentage from the total cropped area of the whole region.
Source: Directorate of Agricultural Statistics, Aligarh, U.P.

Table 4.15
Growth rate in Area, Production and Yield of Major Crops in Aligarh District (1996-97 to 2011-12)
(Figure in Percentage)

| Years/ Crops | $\begin{gathered} \text { A=Area, } \\ \mathbf{P}=\text { Production, } \\ \mathbf{Y}=\text { Yield } \end{gathered}$ | 1996-01 | 2001-06 | 2006-11 | $\begin{gathered} 1996-97 \text { to } \\ 2011-12 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Wheat | A | 13.87 | 2.62 | 0.57 | 17.52 |
|  | P | 16.19 | -10.45 | 32.41 | 37.77 |
|  | Y | 3.15 | -13.66 | 31.64 | 17.24 |
| Rice | A | 151.07 | 41.67 | 80.66 | 542.58 |
|  | P | 248.33 | 50.73 | 91.27 | 904.23 |
|  | Y | 38.71 | 6.41 | 5.88 | 56.27 |
| Barley | A | -15.81 | -32.72 | -34.49 | -62.89 |
|  | P | -10.71 | -47.81 | -19.12 | -62.31 |
|  | Y | 6.05 | -22.43 | 23.45 | 1.56 |
| Millet | A | 8.66 | 3.90 | 5.50 | 19.10 |
|  | P | -15.95 | 38.39 | 18.77 | 38.14 |
|  | Y | -22.62 | 33.18 | 12.57 | 16.02 |
| Maize | A | -3.43 | -39.11 | -33.74 | -61.04 |
|  | P | 13.04 | -52.21 | -16.51 | -54.90 |
|  | Y | 17.06 | -21.52 | 25.97 | 15.73 |
| Urad | A | 6.48 | -5.22 | 1.38 | 2.31 |
|  | P | 8.70 | 36.36 | 21.33 | 79.84 |
|  | Y | -2.44 | 43.61 | 19.72 | 67.73 |
| Moong | A | -60.68 | -26.85 | 12.38 | -67.68 |
|  | P | -76.09 | -23.62 | 147.69 | -54.77 |
|  | Y | -39.22 | 4.19 | 120.64 | 39.73 |
| Masur | A | 28.48 | -17.77 | -35.44 | -31.79 |
|  | P | 24.50 | 4.50 | 22.87 | 59.86 |
|  | Y | -3.15 | 27.16 | 90.26 | 134.30 |

Continue.....

| Gram | A | -69.81 | -86.27 | -85.71 | -99.41 |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | P | -61.76 | -90.94 | -79.31 | -99.28 |
|  | Y | 26.59 | -33.81 | 48.29 | 24.26 |
| Pea | A | -56.58 | -81.00 | -56.77 | -96.43 |
|  | P | -44.87 | -89.52 | -37.04 | -96.36 |
|  | Y | 26.93 | -44.85 | 46.02 | 2.21 |
| Pulses | A | -16.53 | -9.21 | -35.87 | -51.40 |
|  | P | -41.51 | -3.26 | -30.63 | -60.75 |
|  | Y | -29.90 | 6.46 | 8.19 | -19.25 |
|  | P | -47.78 | -20.00 | -27.78 | -62.32 |
| Mustard | Y | -17.95 | -32.97 | -6.63 | -62.43 |
|  | P | -59.11 | 32.56 | -18.35 | -55.74 |
|  | P | -63.95 | 20.00 | -1.11 | -57.23 |
| Sugarcane | Y | -11.87 | -9.47 | 21.10 | -3.38 |
|  | P | -24.21 | 5.97 | -24.02 | -38.98 |
|  | P | -15.56 | -0.26 | -23.00 | -35.14 |
|  | Y | 11.42 | -5.88 | 1.35 | 6.29 |
| Potato | A | 41.76 | 125.15 | 74.91 | 458.28 |
|  | P | 60.48 | 101.53 | 72.58 | 608.14 |
|  | Y | 13.21 | -10.49 | -1.33 | 26.84 |

Source: Directorate of Agricultural Statistics, Aligarh, U.P.


Figure 4.22

Figure 4.22 shows a trend line of area and production of wheat. It is clear from the table 4.15 that wheat is registered a linear growth rate in area and production. The area under wheat recorded an increase of 17.52 percent and wheat production increased by 37.77 percent during 1996-97 to 2011-12.

Millet- Millet is the second leading and one of the coarse cereal crops in the region. The area under millet deliberately increased in all periods. It covered an area of 76155 hectares in 1996-97 reached to 82749 hectares in 2001-02. It again increased from 85974 hectares in 2006-07 to 90701 hectares in 2011-12. The production of millet decreased from 126984 metric tonnes in 1996-97 to 106726 metric tons in 2001-02 and increased to 147698 metric tonnes in 2006-07. It further rose to 175416 metric tonnes in 2011-12. The yield rose up from 17.35 quintal per hectare in 1996-97 to 20.31 quintal per hectare in 2001-02 and it declined to 17.18 quintal per hectare in 2006-07 and again increased to 19.34 quintal per hectare in 2011-12. It is seen from the figure 4.22 that the trend line of area and production of millet depicts an upward movement. Table 4.15 shows that the area under millet increased by 19.10 percent while the production increased by 38.14 percent during 1996-97 to 2011-12.

Rice- It is staple food like as wheat and is most extensively cultivated crop of the region. From the table 4.14, it is seen that the area under rice tremendous increased from 13404 hectares in 1996-97 to 86131 hectares in 2011-12. It covered an area of 33654 hectares in 2001-02 and 47676 hectares in 2006-07. Similarly, the production increased from 18700 metric tonnes in 1996-97, to 65137 metric tonnes in 2001-02, to 98179 metric tonnes in 2006-07 and to 187791 metric tonnes in 2011-12. Like area and production, the yield of rice also increased in all quinquenial periods. It increased from 13.95 quintal per hectare in 1996-97 to 19.35 quintal per hectare in 2001-02 and again reached to 20.59 quintal per hectare in 2006-07. It further rose to 21.80 quintal per hectare in 2011-12. Due to high yielding varieties of seeds, improved irrigation facilities, use of insecticides and pesticides and good price promote the cultivation of rice in the study region.

The trend line of area and production of rice depicts a rising trend. It is clearly seen from table 4.15 that rice has been registered a tremendous liner growth in area and
production in the region. The area under rice increased by 542.58 percent from 1996-97 to 2011-12 whereas production increased by 904.23 percent during same period.

Maize -The area under maize gradually declined from 45613 hectares in 1996-97 to 44048 hectares in 2001-02, 26820 hectares in 2006-07 and it again reduced to 17770 hectares in 2011-12. As against this, the production of maize increased from 79125 metric tonnes in 1996-97 to 89440 metric tonnes in 2001-02. It declined from 42740 metric tonnes in 2006-07 to 36683 metric tonnes in 2011-12. There has been increase or decrease in yield during study periods. The yield of maize was 17.35 quintal per hectare in 1996-97 which rose to 20.31 quintal per hectare in 2001-02 but in 2006-07, it declined to 15.94 quintal per hectare while in 2011-12, it increased to 20.08 quintal per hectare. The reason for the decrease area of maize is the low yield and low price than wheat and rice.

The trend line of area and production of maize shows a downward trend. It is evident from the table 4.15 that maize area registered a gradual negative growth while production shows a positive growth in first quinquenial period and negative growth has been in last two quinquenial period. Overall analysis of fifteen years i.e. from 1996-97 to 2011-12, the area under maize decreased by 61.04 percent and production decreased by 54.90 percent.

Barley- It is also a coarse cereal crop as millet and maize. The area and production gradually fell down during 1996-97 to 2011-12. The area and production of barley was 25879 hectares and 79766 metric tonnes in 1996-97 which reduced to 21788 hectares and 79766 metric tonnes in 2001-02. Again it decreased to 14658 hectares and 41628 metric tonnes in 2006-07 and further declined to 9603 hectares and 33669 metric tons in 201112. The yield of barley shows fluctuation trend. The average yield of barley increased from 34.52 quintal per hectare in 1996-97 to 36.61 quintal per hectares in 2001-02. It declined to 28.4 quintal per hectare in $2006-07$ and it expanded up to 35.06 quintal/hectare in 2011-12.

It is clear from the table 4.15 that linear growth rate of area under barley recorded a negative growth of 62.89 percent while production decreased by 62.31 percent during study periods. The trend line of area and production of barley is depicted in figure 4.22.

Arhar- Arhar is the most dominant pulse in all pulses. The area as well as production slowly declined during fifteen years. The area under arhar was 20771 hectare in 1996-97 and it was decreased by 3433 hectares in 2001-02. It again declined to 15741 hectares in 2006-07 and further decreased to 10094 hectares in 2011-12. Similarly, there has also been a gradual decline in the production of arhar from 18347 metric tonnes in 1996-97 to 10731 metric tons in 2001-02, 10381 metric tonnes in 2006-07, 7201 metric tonnes in 2011-12. But there has been fluctuation in yield. It has decreased from 8.83 quintal/hectare to 6.19 quintal/hectare in first quinquenial period. It rose to 6.59 quintal/hectare in 2006-07 which reached up to 7.13 quintal/hectare.

The trend line of area and production plotted in figure 4.23 depicts a declining pattern. It is evident from the table 4.15 that linear growth rate of area and production of arhar has a negative growth of 51.40 percent and 60.75 percent respectively during the period from 1996-97 to 2011-12.

Moong- Moong is the second leading pulse after arhar. The area under moong covered an area of 12103 hectares in 1996-97 declined to 4759 hectares in 2001-02 and again decreased by 1278 hectares in the year 2006-07. It increased by only 431 hectares in 2011-12. The production and yield of moong follow same trend. The production and yield has decreased from 7119 metric tonnes and 5.89 quintal/hectare in 1996-97 to 1702 metric tons and 3.58 quintal/hectare in 2001-02 and again fell down to 1300 metric tonnes and 3.73 quintal/hectare in 2006-07. It rapid increased to 3220 metric tons and 8.23 quintal/hectare in 2011-12.

The trend line of area and production are plotted in figure 4.23. It depicts that the first two quinquenial period registered negative growth and positive growth registered in last quinquenial period. During fifteen years from 1996-97 to 2011-12, the area under moong declined by 67.68 percent and production of it decreased by 54.77 percent.

## ALIGARH DISTRICT



Figure 4.23

Masur- There is small fluctuation in area under masur. It registered 1752 hectares in 1996-97, 2251 hectares in 2001-02, 1851 hectares in 2006-07 and 1195 hectares in 201112 whereas the production of masur shows a gradual increase. It increased from 1445 metric tonnes in 1996-97 to 1799 metric tonnes in 2001-02, to 1880 metric tonnes in 2006-07 and 2310 metric tonens in 2011-12. The yield has been recorded as 8.25 quintal/hectare in 1996-97 and it declined to 7.99 quintal/hectare in 2001-02. It decreased from 10.16 quintal/hectare in 2006-07 to 19.33 quintal/hectare in 2011-12.

Figure 4.23 shows different pattern of area and production of moong. The area shows downward but production depicts an upward trend. The trend line of area under masur shows a negative growth i.e. 31.79 percent while production registered positive growth rate by 59.86 percent during 1996-97 to 2011-12.

Urad- There is slight increase or decrease in area of urad. The area covered 648 hectares in 1996-97, 690 hectares in 2001-02, 654 hectares in 2006-07 and 666 hectares in 201112. The production recorded as 253 metric tonnes in 1996-97, 275 metric tonnes in 200102, 375 metric tonnes in 2006-07 and 455 metric tonnes in 2011-12 while the yield decreased from 4.09 quintal/hectare in 1996-97 to 3.99 quintal/hectare in 2001-02 and increased to 5.73 quintal/hectare. It further rose to 6.86 quintal/hectare.

Both area and production of urad recorded positive growth. There is slow positive growth in area i.e. 2.31 percent but 79.84 percent positive growth has been recorded in production during 1996-97 to 2011-12.

Pea- The area and production of pea observed a rapid decline rate. The area and production occupied by pea was 3673 hectares and 5143 metric tonnes in 1996-97 respectively. It declined to 1595 hectares and 2835 metric tons in 2001-02, again reduced to 303 hectares and 297 metric tonnes in 2006-07. It further fell to 131 hectares and 187 metric tonnes in 2011-12 respectively. Opposite this, the yield of pea rose from 14 quintal/hectare in 1996-97 to 17.77 quintal/hectare. It declined to 9.8 quintal/hectare in 2006-07 and it rose to 14.31 quintal/hectare in 2011-12.

The trend line of area and production given in figure 4.23 are an evidence of a downward trend with regard to pea cultivation. It is clear from the table 4.15 that area
declined by 96.43 percent and production decreased by 96.36 percent during fifteen years.

Gram- Like pea, farmers do not prefer to grow gram due to low yield while it is source of protein. Both area and production of gram consistently decreased sharply in the study region. In the year of 2011-12, the area and production recorded negligible. Its area declined from 3547 hectares in 1996-97 to 1071 hectares in 2001-02 and again came down to 147 hectares in 2006-07 then to 21 hectares in 2011-12. The production of gram decreased from 3347 metric tons in 1996-97 to 24 metric tonnes in 2011-12. The yield of gram observed fluctuation in different quinquenial period. The yield rose from 9.44 quintal/hectare in 1996-97 to 11.95 quintal/hectare but fell to 7.91 quintal/hectare in 2006-07. It further reached to 11.73 quintal/hectare in 2011-12. The trend line in figure 4.23 shows that the area and production record negative growth speedily i.e. more than 99 percent.

Overall analysis of pulses, the farmers are not interested to grow pulses due to low yield, lack of High Yielding Varieties of seeds and susceptible to diseases. The farmers prefer to grow vegetables than pulses.

Mustard- Mustard is the main oilseed crop. It is usually sown alone as well as mixed with gram, wheat and barley etc. Mustard covers more than 99 percent area out of total oilseeds and remaining covers by sunflower in Aligarh district. The area under mustard was 40431 hectares in 1996-97 which declined to 16531 hectares in 2001-02, but in next period the area increased to 21914 hectares and it again down to 17893 hectares in 201112 whereas the production covered by mustard was 56197 metric tonnes in 1996-97, but in 2001-02 it declined to 20257 metric tonnes and then to 24308 metric tonnes in 200607, 24037 metric tons in 2011-12.

The trend line of area and production of mustard which is plotted in figure 4.24 shows a fluctuating trend. Table 4.14 depicts that the area and production recorded negative growth in first quinquenial period and observed positive growth in second quinquenial period. Both area and production of it registered negative growth in last


Figure 4.24

Trend of Growth in Area and Production of Cash Crops



Figure 4.25
quinquenial period. During 1996-97 to 2011-12, mustard records a negative growth in area and production i.e. 55.74 percent and 57.23 percent respectively.

Sugarcane- Aligarh district is one of the districts of sugarcane belt in western Uttar Pradesh and it is not an important producer of sugarcane like other district of western Uttar Pradesh. The area and production of sugarcane slowly decreased during study periods. The area of sugarcane increased from 12019 hectares in 1996-97 to 9109 hectares in 2001-02 which decreased to 544 hectares in 2006-07 and again declined to 7334 hectares in 2011-12. There has been a gradual decline in production from 684170 metric tonnes in 1996-97, to 577729 metric tonnes in 2001-02, to 576245 metric tonnes in 2006-07 and 443736 metric tonnes in 2011-12. The yield of sugarcane rose from 569.24 quintal/hectare in 1996-97 to 634.24 quintal/hectare in 2001-02, but declined to 596.96 quintal/hectare in 2006-07 and further inclined to 605.04 quintal/hectare in 201112.

Figure 4.25 shows a downward pattern of area and production of sugarcane. The area decreased by 38.98 percent while production declined by 35.14 percent from 199697 to 2011-12. The reason of this decline is exhaustion of soils, lack of modern agriculture inputs of sugarcane, poor varieties of cane, small and fragmented holdings and traditional method of cultivation.

Potato- After rice, potato enormous increased in area and production. The area under potato was 23861 hectares in 2011-12 as against it was 4274 hectares in 1996-97. Similarly, the production increased from 98713 metric tonnes in 1996-97 to 699032 metric tonnes in 2011-12. The yield of potato was 230.96 quintal/hectare in 1996-97, 261.46 quintal/hectare in 2001-02, 234.03 quintal/hectare in 2006-07 and 292.96 quintal/hectare in 2011-12.

The trend line of area and production of potato are plotted in figure 4.25. This figure shows a rising trend in both area and production. The area has increased by 458.28 percent while production recorded 339.91 percent during fifteen years.

## c) Block-wise Growth Rate in Area, Production and Yield of Major Crops in

 Aligarh District (1996-97 to 2011-12)There has been also tried to highlight the growth rate in area, production and yield of cereals (rice, wheat, barley, millet and maize), pulses, oilseed (mustard) and major cash crops (sugarcane and potato) at block levels from 1996-97 to 2011-12. Among cereals, rice, wheat and millet recorded positive growth whereas barley and maize registered negative growth rate. The pulses and oilseed both have been found decrease in area and production during these fifteen years. The area and production of sugarcane decreased whereas the area and production of potato increased in the study region during 1996-97 to 2011-12. We have discussed it following thoroughly-

Wheat- All blocks report positive growth in area and production except Iglas block. The highest positive growth in wheat area has been seen in Jawan ( 29.46 percent) and Akrabad ( 25.74 percent) while Bijouli observes lowest increase in area i.e. 8.79 percent. Iglas records negative growth by 20.47 percent during 1996-97 to 2011-12.

Akrabad records highest increase in production by 65.28 percent followed by Jawan ( 54.01 percent) and Bijouli reports lowest growth rate by 30.58 percent. The negative growth has been found only in Iglas block i.e. 0.21 percent in the production of wheat over the fifteen years.

The yield of wheat shows increase growth in all blocks. The high growth rate of above 19.65 percent has been recorded in Akrabad, Iglas and Atrouli. The low growth in yield has been observed in Bijouli (14.07percent), Jawan (13.49 percent), Gonda (11.10 percent), and Dhanipur (10.68 percent).

Rice- Out of all crops, rice rapidly increased in terms of area, production and yield in all blocks of Aligarh district during 1996-97 to 2011-12. All blocks of Aligarh district register only positive growth in area and production. The reason is that irrigation facilities have been improved and price of rice are also good. Table 4.16 shows that Iglas records highest increase of 3555 percent followed by Chandaus (2278 percent), Lodha (1927 percent) whereas between 547 percent and 1608 percent growth rate

Table 4.16
Block-wise Growth Rate in Area, Production, Yield of Wheat, Rice and Barley in Aligarh District (1996-97 to 2011-12)
(Percentage)

| Blocks | WHEAT |  |  | RICE |  |  | BARLEY |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Area | Production | Yield | Area | Production | Yield | Area | Production | Yield |
| Tappal | 16.55 | 33.47 | 16.37 | 256 | 355 | 26.63 | -67.79 | -68.14 | -1.30 |
| Khair | 15.81 | 33.82 | 15.61 | 1234 | 1947 | 56.85 | -71.85 | -71.87 | 1.01 |
| Chandaus | 19.07 | 37.7 | 15.55 | 2278 | 3850 | 62.16 | -65.86 | -65.05 | -0.59 |
| Jawan | 29.46 | 54.01 | 13.49 | 507 | 819 | 54.23 | -56.64 | -54.74 | 3.80 |
| Lodha | 15.51 | 34.34 | 17.05 | 1927 | 3846 | 78.79 | -58.55 | -58.24 | 4.84 |
| Dhanipur | 21.87 | 41.44 | 10.68 | 535 | 973 | 70.43 | -74.49 | -73.61 | 5.05 |
| Akrabad | 25.74 | 65.28 | 27.22 | 195 | 304 | 43.77 | -73.40 | -72.70 | 2.50 |
| Gonda | 13.27 | 35.04 | 11.10 | 1483 | 2548 | 43.39 | -70.47 | -69.72 | 3.57 |
| Iglas | -20.47 | -0.21 | 24.47 | 3555 | 7859 | 74.04 | -79.64 | -78.47 | 6.33 |
| Atrouli | 12.09 | 33.9 | 22.31 | 558 | 832 | 50.24 | -66.49 | -66.80 | 2.31 |
| Bijouli | 8.79 | 30.58 | 14.07 | 66 | 154 | 59.83 | -59.06 | -58.81 | 4.44 |
| Gangiri | 19.45 | 48.39 | 17.12 | 343 | 596 | 60.14 | -34.22 | -32.23 | 3.69 |

Source: Calculated data based on Directorate of Agriculture Statistics, Aligarh

Table 4.17
Categories of Area, Production, Yield of Wheat in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No. of Blocks | Name of Blocks | Range | No. of Blocks | Name of Blocks | Range | No. of Blocks | Name of Blocks |
| High | $\begin{gathered} \hline \text { Above } \\ 21.01 \end{gathered}$ | 3 | Jawan. Dhanipur, Akrabad | $\begin{gathered} \hline \text { Above } \\ 45.16 \end{gathered}$ | 3 | Jawan, Akrabad, Gangiri | $\begin{gathered} \hline \text { Above } \\ 19.65 \end{gathered}$ | 3 | Akrabad, Iglas, Atrouli |
| Medium | $\begin{gathered} 8.51 \text { to } \\ 21.01 \end{gathered}$ | 8 | Tappal, Khair, Chandaus, Lodha, Gonda, Atrouli, Bijouli, Gangiri | $\begin{gathered} 29.47 \text { to } \\ 45.16 \end{gathered}$ | 8 | Tappal, Khair, Chandaus, Lodha, Dhanipur, Gonda, Atrouli, Bijouli | $\begin{gathered} 14.53 \\ \text { to } \\ 19.65 \\ \hline \end{gathered}$ | 5 | Tappal, Khair, Chandaus, Lodha, Gangiri |
| Low | $\begin{gathered} \hline \text { Below } \\ 8.51 \\ \hline \end{gathered}$ | 1 | Iglas | $\begin{gathered} \hline \text { Below } \\ 29.47 \\ \hline \end{gathered}$ | 1 | Iglas | $\begin{gathered} \hline \text { Below } \\ 14.53 \end{gathered}$ | 4 | Jawan, Dhanipur, Gonda, Bijouli |

Table 4.18
Categories of Area, Production, Yield of Rice in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of <br> Blocks | Name of Blocks | Range | No of <br> Blocks | Name of Blocks | Range | No of <br> Blocks | Name of Blocks |
| High | Above <br> 1608.86 | 3 | Chandaus, Lodha, Iglas | Above <br> 3137.44 | 3 | Chandaus, Lodha, Iglas | Above <br> 63.98 | 3 | Lodha, Dhanipur, Iglas |
| Medium | 547.31 to <br> 1608.86 | 3 | Khair, Gonda, Atrouli | 876.39 <br> to 3137.44 | 3 | Khair, Dhanipur, Gonda | 49.44 to <br> 63.98 | 6 | Khair, Chandaus, Jawan, <br> Atrouli, Bijouli, Gangiri |
| Low | Below <br> 547.31 | 6 | Tappal, Jawan, Dhanipur, <br> Akrabad, Bijouli, Gangiri | Below <br> 876.39 | 6 | Tappal, Jawan, Akrabad, <br> Atrouli, Bijouli, Gangiri | Below <br> 49.44 | 3 | Tappal, Akrabad, Gonda |

Table 4.19
Categories of Area, Production, Yield of Barley in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks |
| High | $\begin{aligned} & \text { Above } \\ & -58.92 \end{aligned}$ | 3 | Jawan, Lodha, Gangiri | $\begin{aligned} & \text { Above } \\ & -58.07 \end{aligned}$ | 2 | Jawan, Gangiri | $\begin{gathered} \hline \text { Above } \\ 4.12 \\ \hline \end{gathered}$ | 4 | Lodha, Dhanipur, Iglas, Bijouli |
| Medium | $\begin{gathered} \hline-70.82 \text { to } \\ -58.92 \\ \hline \end{gathered}$ | 5 | Tappal, Chandaus, Gonda, Atrouli, Bijouli | $\begin{gathered} \hline-70.33 \text { to } \\ -58.07 \\ \hline \end{gathered}$ | 6 | Tappal, Chandaus, Lodha, Gonda, Atrouli, Bijouli | $\begin{gathered} \hline 1.82 \text { to } \\ 4.12 \\ \hline \end{gathered}$ | 5 | Jawan, Akrabad, Gonda, Gangiri |
| Low | $\begin{aligned} & \hline \text { Below } \\ & -70.82 \end{aligned}$ | 4 | Khair, Dhanipur, Akrabad, Iglas | $\begin{aligned} & \text { Below } \\ & -70.33 \end{aligned}$ | 4 | Khair, Dhanipur, Akrabad, Iglas | $\begin{gathered} \text { Below } \\ 1.82 \end{gathered}$ | 3 | Tappal, Khair, Chandaus |

[^5]

Figure 4.26


Figure 4.27


Figure 4.28
has been found in three blocks namely, Khair, Gonda and Atrouli. Below 547 percent has been observed in Dhanipur, Jawan, Gangiri, Tappal, Akrabad and Bijouli in which Bijouli reports lowest growth rate i.e. 66 percent.

It is seen from the figure 4.27 that the maximum positive growth in production has been recorded by Iglas ( 7859 percent) followed by Chandaus ( 3850 percent) and Lodha (3846 percent) whereas Bijouli (154 percent) and Tappal (355 percent) register low increase over the period from 1996-97 to 2011-12.

Table 4.18 indicates that during 1996-97 to 2011-12, yield of rice has been recorded high growth of 78.79 percent, 74.04 percent and 70.43 percent in the blocks, namely, Lodha, Iglas and Dhanipur respectively. Only six blocks show medium growth, namely, Khair, Chandaus, Jawan, Atrouli, Bijouli and Gangiri whereas the blocks, namely, Tappal ( 26.63 percent), Akrabad ( 43.77 percent) and Gonda (43.39 percent) show low growth.

Barley- Figure 4.28 shows that both area and production of barley receive negative growth rate in all blocks of the district whereas the yield records positive growth except two blocks during 1996-97 to 2011-12. During this period, the higher decrease has been recorded in Iglas, Dhanipur, Akrabad, and Khair (below -70 percent) in terms of area and production due to increase in area and production under wheat. Gangiri block registers low decrease in area and production by -34.22 percent and -32.23 percent respectively. Only two blocks, namely Tappal and Chandaus represent negative growth in yield of barley by -1.30 percent and -0.59 percent respectively from 1996-97 to 2011-12. During this period, the high increase in yield of barley has been recorded in four blocks, namely, Iglas ( 6.33 percent), Dhanipur ( 5.05 percent), Lodha ( 4.84 percent), and Bijouli (4.44 percent). Khair block registers with low positive growth by only 1.01 percent. There are five blocks which is characterized with medium positive growth in yield of barley.

Millet- Table 4.21 shows that the growth rate in area under millet reports that there are nine blocks namely, Chandaus, Dhanipur, Lodha, Gangiri, Akrabad, Bijouli, Gonda and Jawan which record positive change while Khair, Atrouli and Iglas observe negative growth rate. On the other hand, the production and yield of millet register positive growth in all blocks. Out of total blocks, Chandaus reports the highest increase with 73.03
percent and Atrouli records lowest increase with 1.02 percent in terms of production. The highest growth rate has been shown in Khair by 32.35 percent whereas the lowest in Atrouli by 2.02 percent in terms of yield.

Maize- It is clear from the figure 4.30 that only negative changes have been observed in both the area and production of all blocks. Chandaus block registers highest negative growth in area and production of maize i.e. 84.37 percent and 81.09 percent respectively while lowest negative growth observes in Atrouli block of 41.19 percent and 31.96 percent with respect to area and production. All blocks register positive growth in yield of maize except Akrabad. Akrabad records negative growth rate of -36.40 percent. The highest increase in yield has been observed in Khair ( 27.36 percent) and the lowest increase has been found in Gonda (8.07 percent).

Pulses- The important pulses of the region are Urad, Moong, Masur, Arhar, Pea and Gram in which Arhar is the most dominant pulse. Figure 4.31 depicts that decreasing trend has been observed in area and production of pulses. The higher decrease in area and production under pulses has been observed in Akrabad, Gonda and Gangiri above -70 percent during fifteen years. It is seen from the table 4.23 that there are six and five blocks that show medium decrease with respect to area and production. The low decrease in area has been observed in three blocks namely Tappal (-53.10 percent), Chandaus (55.10 percent) and Iglas ( -56.59 percent) whereas low negative growth rate has been recorded in four blocks namely, Tappal (-50.15 percent), Lodha ( -50.50 percent), Dhanipur (-53.22 percent) and Chandaus (-54.90 percent).

As shown in figure 4.31, the yield of pulses registers a positive growth in all blocks. High growth has been seen in Lodha ( 38.14 percent), Akrabad ( 32.66 percent) and Iglas ( 25.91 percent). Medium growth in yield of pulses range between 17.60 percent and 25.38 percent has been registered in four blocks, namely, Khair, Chandaus, Dhanipur and Bijouli. Low growth range below 17.60 percent has been seen in five blocks namely, Tappal, Jawan, Gonda, Atrouli and Gangiri.

Table 4.20
Block-wise Growth Rate in Area, Production, Yield of Millet, Maize, Pulses in Aligarh District (1996-97 to 2011-12)
(Percentage)

| Blocks | MILLET |  |  | MAIZE |  |  | PULSES |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Area | Production | Yield | Area | Production | Yield | Area | Production | Yield |
| Tappal | 7.31 | 13.45 | 4.48 | -78.82 | -74.47 | 21.92 | -53.10 | -50.15 | 16.14 |
| Khair | -7.88 | 23.18 | 32.35 | -82.70 | -77.83 | 27.36 | -62.81 | -59.00 | 21.25 |
| Chandaus | 34.21 | 73.03 | 27.33 | -84.37 | -81.09 | 20.49 | -55.10 | -54.90 | 22.00 |
| Jawan | 8.44 | 12.29 | 2.17 | -51.73 | -46.29 | 9.78 | -59.59 | -60.25 | 11.36 |
| Lodha | 32.35 | 53.69 | 14.81 | -70.14 | -62.24 | 22.67 | -61.38 | -50.50 | 38.14 |
| Dhanipur | 32.68 | 54.36 | 14.94 | -82.79 | -80.40 | 14.05 | -59.90 | -53.22 | 22.78 |
| Akrabad | 28.14 | 51.71 | 25.58 | -77.05 | -71.20 | -36.40 | -76.64 | -71.26 | 32.66 |
| Gonda | 21.61 | 46.08 | 18.73 | -81.01 | -76.84 | 8.07 | -73.28 | -75.05 | 13.49 |
| Iglas | -0.38 | 17.50 | 17.16 | -77.41 | -69.76 | 12.01 | -56.59 | -56.19 | 25.91 |
| Atrouli | -1.65 | 1.02 | 2.02 | -41.19 | -31.96 | 14.21 | -62.99 | -60.70 | 16.09 |
| Bijouli | 23.68 | 44.93 | 15.83 | -59.64 | -51.10 | 19.96 | -59.75 | -59.66 | 20.53 |
| Gangiri | 29.19 | 60.59 | 22.92 | -43.05 | -34.27 | 15.73 | -72.10 | -70.26 | 17.53 |
| Soure: Cala |  |  |  |  |  |  |  |  |  |

Source: Calculated data based on Directorate of Agriculture Statistics, Aligarh

Table 4.21
Categories of Area, Production, Yield of Millet in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks |
| High | $\begin{gathered} \hline \text { Above } \\ 24.92 \\ \hline \end{gathered}$ | 5 | Chandaus, Lodha, Dhanipur, Akrabad | $\begin{gathered} \hline \text { Above } \\ 49.16 \end{gathered}$ | 5 | Chandaus, Lodha, Dhanipur, Akrabad | $\begin{gathered} \hline \text { Above } \\ 21.44 \end{gathered}$ | 4 | Khair, Chandaus, Akrabad, Gangiri |
| Medium | $\begin{gathered} \hline 9.70 \text { to } \\ 24.92 \end{gathered}$ | 2 | Gonda, Bijouli | $\begin{gathered} \hline 26.15 \text { to } \\ 49.16 \end{gathered}$ | 3 | Gonda, Bijouli | $\begin{gathered} \hline 11.61 \text { to } \\ 21.44 \end{gathered}$ | 5 | Lodha, Dhanipur, Gonda, Iglas, Bijouli |
| Low | $\begin{gathered} \hline \text { Below } \\ 9.70 \\ \hline \end{gathered}$ | 4 | Tappal, Khair, Jawan, Iglas, Atrouli | $\begin{aligned} & \hline \text { Below } \\ & 26.15 \\ & \hline \end{aligned}$ | 4 | Tappal, Khair, Jawan, Iglas, Atrouli | $\begin{gathered} \hline \text { Below } \\ 11.61 \\ \hline \end{gathered}$ | 3 | Tappal, Jawan, Atrouli |

Source: Computed by Researcher based on table 4.20
Table 4.22
Categories of Area, Production, Yield of Maize in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks |
| High | Above 61.15 | 4 | Jawan, Atrouli, Bijouli, Gangiri | $\begin{gathered} \hline \text { Above - } \\ 54.21 \end{gathered}$ | 4 | Jawan, Atrouli, Bijouli, Gangiri | $\begin{gathered} \hline \text { Above } \\ 20.70 \end{gathered}$ | 3 | Tappal, Khair, Jawan |
| Medium | $\begin{gathered} -77.17 \\ \text { to } \\ -61.15 \end{gathered}$ | 2 | Lodha, Akrabad | $\begin{gathered} -72.03 \\ \text { to } \\ -54.21 \end{gathered}$ | 3 | Lodha, Akrabad, Iglas | $\begin{gathered} 4.27 \\ \text { to } 20.70 \end{gathered}$ | 8 | Chandaus, Jawan, Dhanipur, Gonda, Iglas, Atrouli, Bijouli, Gangiri |
| Low | $\begin{aligned} & \hline \text { Below } \\ & -77.17 \end{aligned}$ | 6 | Tappal, Khair, Chandaus, Dhanipur, Gonda, Iglas | $\begin{aligned} & \hline \text { Below } \\ & -72.03 \end{aligned}$ | 5 | Tappal, Khair, Chandaus, Dhanipur, Gonda | $\begin{gathered} \hline \text { Below } \\ 4.27 \end{gathered}$ | 1 | Akrabad |

Source: Computed by Researcher based on table 4.20
Table 4.23
Categories of Area, Production, Yield of Pulses in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks |
| High | $\begin{gathered} \hline \text { Above - } \\ 59.05 \end{gathered}$ | 3 | Tappal, Chandaus, Iglas | $\begin{aligned} & \hline \text { Above } \\ & -56.01 \end{aligned}$ | 4 | Tappal, Chandaus, Lodha, Dhanipur, | $\begin{gathered} \hline \text { Above } \\ 25.38 \end{gathered}$ | 3 | Lodha. Akrabad, Iglas |
| Medium | $\begin{gathered} \hline-66.49 \\ \text { to } \\ -59.05 \end{gathered}$ | 6 | Khair, Jawan, Lodha, Dhanipur, Atrouli, Bijouli | $\begin{gathered} -64.18 \\ \text { to } \\ -56.01 \end{gathered}$ | 5 | Khair, Jawan, Iglas, Atrouli, Bijouli | $\begin{gathered} 17.60 \\ \text { to } \\ 25.38 \end{gathered}$ | 4 | Khair, Chandaus, Dhanipur, Bijouli |
| Low | $\begin{gathered} \hline \text { Below } \\ -66.49 \end{gathered}$ | 3 | Akrabad, Gonda, Gangiri | $\begin{aligned} & \hline \text { Below } \\ & -64.18 \end{aligned}$ | 3 | Akrabad, Gonda, Gangiri | $\begin{gathered} \hline \text { Below } \\ 17.60 \end{gathered}$ | 5 | Tappal, Jawan, Gonda, Atrouli, Gangiri |

[^6]

Figure 4.29


Figure 4.30


Figure 4.31

Mustard- During the year from 1996-97 to 2011-12, the area and production of mustard decreased in all blocks whereas the yield show both positive and negative growth rate Except Tappal and Jawan blocks, all blocks follow same trend of decrease in area and production. Tappal and Khair record low decrease in area under mustard while they receive medium growth in production. Other four blocks namely, Khair, Lodha, Akrabad and Gangiri record medium growth in both area and production. The high decrease in area and production has been observed in three blocks namely, Dhanipur, Gonda and Iglas.

It is evident from the figure 4.32 that the growth pattern of yield of mustard is different from area and production. Table 4.25 shows that there are three blocks namely, Khair, Chandaus and Bijouli which record positive growth out of which Chandaus has maximum growth i.e. 9.69 percent. Higher negative growth in yield has been seen in Tappal, Jawan, Dhanipur, Akrabad, and Gangiri below -10 percent during fifteen years.

Sugarcane- All blocks receive negative change in area and production except Chandaus block over the period from 1996-97 to 2011-12. Figure 4.33 shows that Gonda and Iglas register highest negative growth rate regarding both area and production more than 96 percent. The reason behind it is that the farmers prefer to grow potatoes in place of sugarcane. Only Chandaus block receives positive change both in area and production with 11.24 percent and 12.68 percent respectively. High decrease growth rate has been observed in five blocks namely, Dhanipur, Akrabad, Gonda, Iglas, Atrouli in terms of area and production below -65 percent. Low decrease in both area and production has been recorded in four blocks above -20 percent i.e. Tappal, Khair, Bijouli and Gangiri.

In terms of yield, there are nine blocks which register positive growth over the period from 1996-97 to 2011-12. They are Khair, Jawan, Lodha, Dhanipur, Gonda, Iglas, Atrouli, Bijouli and Gangiri out of which Iglas records highest positive growth in yield of sugarcane by 29.62 percent whereas three blocks namely, Tappal ( -3.88 percent), Chandaus (-3.39 percent) and Akrabad (-8.27 percent) record negative growth.

Potato- There is a remarkable change in area and production under potato cultivation during 1996-97 to 2011-12. The growth rate of area, production and yield of potato

Table 4.24
Block-wise Growth Rate in Area, Production, Yield of Mustard, Sugarcane and Potato in Aligarh District (1996-97 to 2011-12)
(Percentage)

| Blocks | MUSTARD |  |  | SUGARCANE |  |  | POTATO |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Area | Production | Yield | Area | Production | Yield | Area | Production | Yield |
| Tappal | -43.77 | -50.49 | -11.95 | -18.53 | -15.08 | -3.88 | 425.83 | 445.46 | 3.68 |
| Khair | -53.92 | -53.53 | 0.84 | -9.27 | -8.90 | 0.07 | 438.72 | 502.86 | 11.86 |
| Chandaus | -42.81 | -37.13 | 9.69 | 11.24 | 12.68 | -3.39 | 361.65 | 390.72 | 6.25 |
| Jawan | -44.74 | -50.20 | -10.18 | -51.92 | -50.63 | 8.54 | 86.27 | 138.64 | 28.04 |
| Lodha | -57.98 | -58.89 | -2.13 | -45.56 | -32.66 | 20.85 | 1146.63 | 1274.06 | 10.16 |
| Dhanipur | -66.27 | -69.99 | -11.03 | -70.77 | -67.09 | 11.45 | 98.60 | 182.62 | 42.23 |
| Akrabad | -52.68 | -60.97 | -17.52 | -65.23 | -64.39 | -8.27 | 139.18 | 178.28 | 16.29 |
| Gonda | -77.37 | -77.66 | -1.24 | -96.46 | -96.04 | 18.65 | 820.63 | 1118.26 | 32.27 |
| Iglas | -85.77 | -86.92 | -7.93 | -97.81 | -97.80 | 29.62 | 752.52 | 962.57 | 24.64 |
| Atrouli | -39.02 | -39.74 | -1.14 | -68.26 | -65.67 | 9.35 | 49.87 | 138.28 | 58.98 |
| Bijouli | -40.97 | -40.32 | 1.12 | -8.48 | -0.16 | 10.09 | 153.85 | 340.21 | 73.4 |
| Gangiri | -51.01 | -57.17 | -12.55 | -20.09 | -19.10 | 0.67 | 75.90 | 122.21 | 26.33 |

Source: Calculated data based on Directorate of Agriculture Statistics, Aligarh

Table 4.25
Categories of Area, Production, Yield of Mustard in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks |
| High | Above 47.25 | 4 | Tappal, Chandaus, Jawan, Atrouli, Bijouli, | $\begin{aligned} & \hline \text { Above } \\ & -49.26 \end{aligned}$ | 3 | Chandaus, Atrouli, Bijouli | $\begin{gathered} \hline \text { Above } \\ -1.47 \end{gathered}$ | 4 | Khair, Chandaus, Gonda, Atrouli, Bijouli |
| Medium | $\begin{gathered} -62.14 \\ \text { to } \\ -47.25 \end{gathered}$ | 5 | Khair, Lodha, Akrabad, Gangiri | $\begin{gathered} -64.58 \\ \text { to } \\ -49.26 \end{gathered}$ | 6 | Tappal, Khair, Jawan, Lodha, Akrabad, Gangiri | $\begin{gathered} -9.20 \\ \text { to } \\ -1.47 \\ \hline \end{gathered}$ | 2 | Lodha, Iglas |
| Low | $\begin{gathered} \hline \text { Below - } \\ 62.14 \end{gathered}$ | 3 | Dhanipur, Gonda, Iglas, | $\begin{aligned} & \hline \text { Below } \\ & -64.58 \end{aligned}$ | 3 | Dhanipur, Gonda, Iglas, | $\begin{gathered} \hline \text { Below } \\ -9.20 \\ \hline \end{gathered}$ | 5 | Tappal, Jawan, Dhanipur, Akrabad, Gangiri |

Source: Computed by Researcher based on table 4.24
Table 4.26
Categories of Area, Production, Yield of Sugarcane in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks |
| High | $\begin{gathered} \text { Above - } \\ 27.13 \end{gathered}$ | 5 | Tappal, Khair, Chandaus, Bijouli, Gangiri | $\begin{aligned} & \text { Above } \\ & -23.62 \end{aligned}$ | 3 | Tappal, Khair, Chandaus, Bijouli, Gangiri | $\begin{gathered} \text { Above } \\ 13.48 \end{gathered}$ | 3 | Lodha, Gonda, Iglas |
| Medium | $\begin{gathered} -63.05 \\ \text { to } \\ -27.13 \end{gathered}$ | 2 | Jawan, Lodha | $\begin{gathered} -60.51 \\ \text { to } \\ -23.62 \end{gathered}$ | 4 | Jawan, Lodha | $\begin{gathered} \hline 2.14 \\ \text { to } \\ 13.48 \end{gathered}$ | 4 | Jawan, Dhanipur, Atrouli, Bijouli, |
| Low | $\begin{gathered} \hline \text { Below - } \\ 63.05 \end{gathered}$ | 5 | Jawan, Dhanipur, Akrabad, Gonda, Iglas, Atrouli | $\begin{aligned} & \hline \text { Below } \\ & -60.51 \end{aligned}$ | 5 | Jawan, Dhanipur, Akrabad, Gonda, Iglas, Atrouli | $\begin{gathered} \hline \text { Below } \\ 2.14 \end{gathered}$ | 5 | Tappal, Khair, Chandaus, Gangiri |

Source: Computed by Researcher based on table 4.24
Table 4.27
Categories of Area, Production, Yield of Potato in Aligarh District (1996-97 to 2011-12)

| Categories | Area |  |  | Production |  |  | Yield |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks | Range | No of Blocks | Name of Blocks |
| High | Above 557.68 | 3 | Lodha, Gonda, Iglas | Above 687.38 | 3 | Lodha, Gonda, Iglas | Above 38.54 | 2 | Dhanipur, Atrouli |
| Medium | $\begin{gathered} 200.60 \text { to } \\ 557.68 \\ \hline \end{gathered}$ | 3 | Tappal, Khair, Chandaus | $\begin{gathered} 278.31 \text { to } \\ 687.38 \\ \hline \end{gathered}$ | 4 | Tappal, Khair, Chandaus, Bijouli | $\begin{gathered} 17.15 \text { to } \\ 38.54 \\ \hline \end{gathered}$ | 5 | Jawan, Gonda, Iglas, Bijouli, Gangiri |
| Low | $\begin{aligned} & \hline \text { Below } \\ & 200.60 \end{aligned}$ | 6 | Jawan, Dhanipur, Akrabad, Atrouli, Bijouli, Gangiri | $\begin{aligned} & \text { Below } \\ & 278.31 \\ & \hline \end{aligned}$ | 5 | Jawan, Dhanipur, Akrabad, Atrouli, Gangiri | $\begin{gathered} \text { Below } \\ 17.15 \\ \hline \end{gathered}$ | 5 | Tappal, Khair, Chandaus, Lodha, Akrabad |

Source: Computed by Researcher based on table 4.24


Figure 4.32


Figure 4.33


Figure 4.34
reveals a good increase in all blocks of the study region. Lodha block registers highest increase in area as well as production with 1146 percent and 1274 percent respectively. After it, Gonda and Iglas records high growth rate in both area and production. Medium growth has been observed in Tappal, Khair and Chandaus in area and production. Low growth has been shown in Jawan, Dhanipur, Akrabad, Atrouli and Gangiri in area and production. Bijouli falls in the low category of growth in area and medium category of production.

Figure 4.34 shows that Atrouli records maximum growth in yield of potato i.e. 58.98 percent followed by Dhanipur ( 42.23 percent). Medium category of growth (between 17.15 percent and 38.54 percent) of yield has been registered in Jawan, Gonda, Iglas, Bijouli and Gangiri. Low growth (below 17.15 percent) has been recorded in five blocks namely, Tappal, Khair, Chandaus. Lodha, Akrabad from 1996-97 to 2011-12.

## 4.2-Crop Rankings

An attempt has been made to demarcate the individual crop on rank basis in order to put as first, second and third rankings. Total ten crops (wheat, rice, millet, maize, barley, mustard, pulses, potato and vegetables) have been considered for study which occupied more than 1 percent area.

## First Ranking Crops

It is clearly evident from the table 4.28 that wheat was the first rank crop in all blocks of districts in both years 1996-97 and 2011-12. It occupies more than 30 percent area to total gross cropped area in all blocks except Iglas in both years.

## Second Ranking Crops

Table 4.28 shows that during 1996-97, three crops namely, millet, maize and pulses occupied second place in crops. Out of these, millet was second dominant crop and it was placed as second crop in eight blocks i.e. Tappal, Khair, Chandaus, Lodha, Gonda, Iglas, Bijouli and Gangiri. It covered area between 10 to 24 percent in these blocks. Maize occupied second position in three blocks i.e. Dhanipur, Jawan and Atrouli, covered

Table 4.28
Ranking of crops in blocks of Aligarh district (1996-97 and 2011-12)

| I rank |  | II rank |  |  |  | III rank |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1996-97 | 2011-12 |  | 1996-97 |  | 2011-12 |  | 1996-97 |  | 2011-12 |
| No. |  | No. | Name | No. | Name | No. | Name | No. |  |
| 12 | 12 |  |  |  |  |  |  |  |  |
|  |  |  |  | 6 | Tappal, Khair, Chandaus, Jawan, Dhanipur, Akrabad | 1 | Akrabad | 3 | Lodha, Gonda, <br> Atrouli |
|  |  | 8 | Tappal, Khair, <br> Chandaus, Lodha, <br> Gonda, Iglas, <br> Bijouli, Gangiri | 5 | Lodha, Gangiri, Atrouli, Bijouli, Gangiri | 1 | Atrouli | 6 | Tappal, Khair, Chandaus, Jawan, Dhanipur, Akrabad |
|  |  | 3 | Dhanipur, Jawan, Atrouli |  |  | 2 | Bijouli, Gangiri | 2 | Bijouli, Gangiri |
|  |  |  |  |  |  | 6 | Tappal, Khair, Chandaus,Lodha, Gonda, Iglas |  |  |
|  |  | 1 | Akrabad |  |  | 2 | Dhanipur, Jawan |  |  |
|  |  |  |  |  |  |  |  | 1 | Iglas |
|  |  |  |  | 1 | Iglas |  |  |  |  |

Source: Computed by Researcher


Figure 4.35


Figure 4.36


Figure 4.37


Figure 4.38


Figure 4.39


Figure 4.40

12 to 15 percent area to total gross cropped area. Pulses ranks as second in only one block i.e. Akrabad (13.77 percent area).

During 2011-12, rice came as second crop replacing millet and maize. In this year, rice ranked second crop in six blocks, namely, Tappal, Khair, Chandaus, Jawan, Dhanipur, and Akrabad. It covered 10 to 30 percent area in these six blocks. Next in importance rice, millet was dominant second rank crop in 5 blocks i.e. Lodha, Gonda, Atrouli, Bijouli, and Gangiri and it covered 15 to 30 percent area. Vegetables ranked second in Iglas block which has 23.10 percent area under vegetables. Maize and pulses were excluded from this category in 2011-12.

## Third Ranking Crops

Table 4.28 represents that 5 crops namely, rice, millet, maize, mustard, and pulses placed as third rank crop in 1996-97. Mustard was dominant as third rank crop in six blocks, namely, Tappal, Khair, Chandaus, Lodha, Gonda and Iglas which covered 8 to 12 percent mustard area to total gross cropped area. Maize ranked third crop in Bijouli and Gangiri having 15.42 percent and 13.70 percent area respectively. Pulses occupied third position in Dhanipur and Jawan blocks, covered 11.90 percent and 13.77 percent area respectively. Rice was dominant as third crop in Akrabad (10.02 percent area) and millet was dominant in Atrouli block (15.60 percent area).

During 2011-12, ranking of crops have changed. Mustard and pulses were excluded from this category while mustard was dominant in 1996-97. Millet was dominant as third rank crop in six blocks, namely, Tappal, Khair, Chandaus, Jawan, Dhanipur, and Akrabad, covered 8 to 13 percent area. Next to millet, Rice ranked third crop in three blocks i.e. Lodha, Gonda and Atrouli having 9.26 percent, 19.05 percent and 12.92 percent area respectively. Maize occupied third rank in Bijouli ( 6.49 percent) and Gangiri (7.62 percent) whereas potato came as third rank crop in Iglas block having 22.83 percent area.

## 4.3- Crop-combination Regions

The study of crop combination regions constitutes an important aspect of land utilization as it provides a good basis for agriculture regionalization. The concept of crop combination is a scientific device to study the existing relationship of crops in association with each other. Crops are generally grown in combination and it is rarely that a particular crop occupies a position of total isolation from other crops in a given aerial unit at a given point of time.

Weaver (1954) was the first who propounded the concept of 'crop-combination’ to delineate crop-combination regions of Middle West in the United States. In spite of its scientific base, it gives a much generalized picture because it considers crops-occupying more than one percent area. To overcome this problem, Doi (1957) and Rafiullah (1965) modified Weaver's Method. Doi's method has been used to delineate the cropcombination regions in the blocks of Aligarh district. In Doi's method, only sum of the squared differences are taken. Thus, the combination having the smallest $\sum \mathrm{d}^{2}$ will be the combination formed by the major crops only. $\sum \mathrm{d}^{2}$ is consulted from the table of critical value which Doi has himself provided. If the critical value is higher than the actual percentage, the crop is not considered, but if otherwise the value is lower than the crop percentage, the crop is included in the combination. According to this technique, all those crops are included in the combination whose cumulative percentage is less than 50. This method was also applied by Ahmad and Siddiqui (1967) and Shafi (1984) in their study for the determination of crop-combination regions. Ahmad and Siddiqui identified 6 crop-combination regions in Luni Basin of Rajasthan for the year 1960-61 and Shafi noticed 2 to 5 crop-combination region in 48 districts of Uttar Pradesh during the period 1966-67 to 1975-76. Crop-combination regions based on Doi's method have been worked out for the year 1996-97 and 2011-12. It is represented in Figure 4.41 and 4.42 respectively.

It is seen from the table 4.29 that a single crop combination is absent in district during 1996-97 and 2011-12. Two to five crop combinations regions have been observed in district.

Table 4.29
Crop Combination Regions in blocks of Aligarh District (1996-97 and 2011-12)

| Crop Combination Region | 1996-97 |  |  | 2011-12 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | No. | Crops | Name of Blocks | No. | Crops | Name of Blocks |
| II Crop <br> Combinations | 2 | W, Mi | Tappal, Gonda | 6 | W, Mi | Lodha, Bijouli, Gangiri |
|  |  |  |  |  | W, R | Jawan, Chandaus, Akrabad |
| III Crop <br> Combinations | 6 | W, Mi, Mu | Khair, Lodha, Iglas | 3 | W, R, Mi | Tappal, Khair, Dhanipur |
|  |  | W, Ma, Mi | Atrouli, |  |  |  |
|  |  | W, Mi, Ma | Bijouli, Gangiri |  |  |  |
| IV Crop Combinations | 2 | W, Mi, Mu, P | Chandaus | 2 | W, V, Po, Mi | Iglas |
|  |  | W, Ma, P, Mi | Jawan |  | W, Mi, R, Ma | Atrouli |
| V Crop Combinations | 2 | W, Ma, P, Mi, Mu | Dhanipur | 1 | W,Mi,R,V,Po | Gonda |
|  |  | W, P, R, Mi, Ma | Akrabad |  |  |  |

Source: Computed by Researcher

## Two crop combinations

It is clear from the figure 4.41 and 4.42 that wheat is dominant crop in all blocks in both years. It is observed that wheat and millet formed a common component for crop combinations in two blocks i.e. Tappal and Gonda in the year of 1996-97.

It is evident from the figure 4.42 that the change in combination has been noticed due to replacement of millet by Rice in 2011-12. The reason for change is due to irrigation, fertilizers and agricultural implements. It is seen from the table 4.29 that twocrop combinations show an increase in number of blocks in 2011-12. Six new blocks, namely Chandaus, Jawan, Lodha, Akrabad, Bijouli and Gangiri were added in this combination whereas Tappal and Gonda showed a shift from this combination to three crop combinations and five crop combinations respectively. Wheat and rice were the

# ALIGARH DISTRICT <br> Crop-Combination Regions <br> (1996-97) 



Figure 4.41


Figure 4.42
common crops in Chandaus, Jawan and Akrabad whereas wheat and millet were dominant crops in Lodha, Bijouli and Gangiri.

## Three crop combinations

It is seen from the table 4.29 that three crop-combinations have been seen in six blocks of Aligarh district during 1996-97. Wheat, millet and mustard were the common crops in Khair, Lodha, and Iglas. Wheat, maize and millet were dominant crops in Atrouli block whereas wheat, millet and maize were common crops in Bijouli and Gangiri blocks.

During 2011-12, three crop-combinations have been observed in three blocks. It has decreased from 6 to 3 blocks having three crop combinations. In this year, two new blocks of Tappal and Dhanipur were added to this combination whereas five blocks were shifted from this combination to other combinations. The blocks namely, Lodha, Bijouli and Gangiri were shifted from this combination to two crop combinations while two blocks namely, Iglas and Atrouli were shifted to four crop combinations. It is seen from the figure 4.42 that wheat, rice and millet were dominant crops in Tappal, Khair and Dhanipur.

## Four crop combinations

It is seen from the table 4.29 that during 1996-97, four crop combinations have been noticed in only two blocks i.e. Chandaus and Jawan. In Chandaus block, wheat, millet, mustard and pulses were the main crops to form this combination whereas wheat, maize, pulses and millet were dominant crops in Jawan block.

During 2011-12, this crop combination was confined to only two blocks, namely, Iglas and Atrouli. Wheat, vegetables, potato and millet were dominant crops in Iglas block, whereas wheat, millet, rice and maize were dominant in Atrouli block.

## Five crop combinations

Table 4.29 shows that five crop combinations have been seen in Dhanipur and Akrabad blocks in 1996-97 and in Gonda block in 2011-12. Wheat, maize, pulses, millet
and mustard formed five crop combinations in Dhanipur block, whereas wheat, pulses, rice, millet and maize formed this combination in Akrabad block. During the period of 2011-12, the block of Gonda was characterized by wheat, millet, rice, vegetables and potato crop combinations.

### 4.4 Cropping Intensity

Cropping intensity signifies a time period when the combination of land, labour, capital and farm management is capable of yielding maximum economic net return (Tandon \& Dhundyal, 1967). It is the main attributes of agricultural productivity because it is intensified related with the expansion and processes of agricultural land use (Singh, 1994). It is calculated as percentage of total cropped area to the net sown area. The availability of advance techniques of agricultural increased in growth of cropping intensity. Table 4.30 reports that there is a wide variation in Aligarh district in cropping intensity. Figure 4.43 represents that the cropping intensity shows high to low from eastern region to western region in the year of 1996-97 whereas the pattern has been changed in 2011-12.

## High Cropping Intensity

In the year 1996-97, only four blocks are reported in the high category of cropping intensity, they are Dhanipur, Akrabad, Atrouli and Bijouli. These blocks have more than 180 cropping intensity out of which Dhanipur records highest cropping intensity i.e. 196.88. Table 4.31 shows that Tappal, Akrabad and Atrouli have high cropping intensity during the year 2011-12. These blocks have more than 184 cropping intensity, out of which Akrabad recorded highest cropping intensity i.e. 195.36

## Medium Cropping Intensity

There are four blocks, reported under medium intensity of cropping i.e. Chandaus, Jawan, Lodha, and Gangiri during the year 1996-97 between 163.34 and 179.97 whereas there were six blocks come under the category of medium intensity of cropping range between 175.60 and 182.69 in the year of 2011-12. They are Gonda (181.69), Bijouli (180.89), Lodha (176.97), Khair (176.89), Iglas (176.48), and Jawan (176.96).

Table 4.30
Cropping intensity in Aligarh district (1996-97 and 2011-12)

| Year/Blocks | $\mathbf{1 9 9 6 - 9 7}$ | $\mathbf{2 0 1 1 - 1 2}$ | Growth Rate |
| :---: | :---: | :---: | :---: |
| Tappal | 150.26 | 184.07 | $\mathbf{2 2 . 5 0}$ |
| Khair | 154.70 | 176.89 | $\mathbf{1 4 . 3 4}$ |
| Chandaus | 167.49 | 174.08 | $\mathbf{3 . 9 3}$ |
| Jawan | 178.44 | 176.47 | $\mathbf{- 1 . 1 1}$ |
| Lodha | 164.33 | 176.96 | $\mathbf{7 . 6 9}$ |
| Dhanipur | 196.88 | 166.75 | $\mathbf{- 1 5 . 3 0}$ |
| Akrabad | 191.55 | 195.36 | $\mathbf{1 . 9 9}$ |
| Gonda | 149.03 | 181.69 | $\mathbf{2 1 . 9 2}$ |
| Iglas | 158.81 | 176.48 | $\mathbf{1 1 . 1 3}$ |
| Atrouli | 181.20 | 185.13 | $\mathbf{2 . 1 7}$ |
| Bijouli | 190.47 | 180.89 | $\mathbf{- 5 . 0 3}$ |
| Gangiri | 176.70 | 174.96 | $\mathbf{- 0 . 9 9}$ |
| Total District | 170.16 | 179.18 | $\mathbf{5 . 3 0}$ |

Source: Calculated data based on Directorate of Agriculture Statistics, Aligarh

Table 4.31
Categories of Cropping Intensity in Aligarh District (1996-97 and 2011-12)

| Categories | 1996-97 |  |  | 2011-12 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Indices | No. of <br> Blocks | Name of the <br> Blocks | Indices | No. of <br> Blocks | Name of the Blocks |
| High | Above <br> 179.97 | 4 | Dhanipur, Akrabad, <br> Atrouli, Bijouli | Above <br> 182.69 | 3 | Tappal, Akrabad, <br> Atrouli |
| Medium | $165.34-$ <br> 179.97 | 4 | Chandaus, Jawan, <br> Lodha, Gangiri | $175.60-$ <br> 182.69 | 6 | Khair, Jawan, Lodha, <br> Gonda, Iglas, Bijouli |
| Low | Below <br> 165.34 | 4 | Tappal, Khair, <br> Gonda, Iglas | Below <br> 175.60 | 3 | Chandaus, Dhanipur, <br> Gangiri |

Source: Computed by Researcher based on table 4.30


Figure 4.43


Figure 4.44

## Low Cropping Intensity

Table 4.31 indicates that there are four blocks which report low intensity of cropping below 165.34 percent during 1996-97. They are Iglas (158.81), Khair (154.70), Tappal (150.26) and Gonda (149.03) whereas there are three blocks namely, Chandaus, Dhanipur and Gangiri report low intensity of cropping i.e. $174.08,173.93$ and 174.96 respectively in the year of 2011-12.


Figure 4.45

The positive growth has been registered in Tappal, Khair, Chandaus, Lodha, Akrabad, Gonda, Iglas, and Atrouli while the negative growth has been found in Jawan, Dhanipur, Bijouli and Gangiri. Tappal block records highest growth in cropping intensity during fifteen years i.e. 22.50 percent followed by Gonda i.e. 21.92 percent whereas Dhanipur registered highest negative growth i.e. 11.65 percent. The reason behind negative growth is that the farmers of this are migrated to Aligarh city in zaid season in search of labour.

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## CHAPIER-5

## SPATIO-TEMORAL $\mathcal{A N} \mathcal{A} \mathcal{L}$ YSIS OF AGRICULTURAL PRODUCTIVITY

### 5.1 Concept of Agricultural Productivity

Agricultural productivity is a key issue of agricultural development. The term agricultural productivity creates various meaning among researchers, geographers, agricultural scientists etc. Some consider it as efficiency with which a production system works, while others defined it as ratio of output to expand resources either separately or collectively. Generally, it is defined as input output ratio in the process of production system. Many efforts have been made to define the connotation of agricultural productivity for long periods. Horring (1964) defines productivity as it denotes the ratio of output to any or all associated inputs. Pandit (1965) has expressed the connotation of productivity in these words: "Productivity is defined in economics as the output per unit of input.......the art of securing an increase in output from a smaller input". Saxon (1965) has given view about productivity as physical relationship between input and output which give rise to that output. The notion of productivity refers to efficiency with which inputs are utilized in agricultural production (Shafi 1967). It may also be defined by Olayide and Heady (1982) as "the ratio of the value of total inputs used in the farm production." Agricultural productivity refers to the output produced by a given level of input in the agricultural sector (Fulginite and Perring 1998). The term productivity is regarded as the measurement of production and inputs required for the production of that output is known as agricultural productivity (Sunil Ogale and Virendra Nagarle, 2014). It is commonly agreed that productivity is the ability of a production system to produce more economically and more efficiently.

Productivity is controlled by various factors. One is influenced by natural factors i.e. weather, soil and climate and on the other hand it is greatly controlled by other factors like labour, land, capital, fertilizers and mechanization. Therefore, agricultural productivity is dynamic, as any modification in the physical factors and improvement of the non-physical factors affect the output of crops per unit of area (Singh \& Dhillon). Dewett (1966) describes, "Productivity expresses the varying relationship between agricultural output and one of the major inputs, like land or labour or capital, other complementary factors remaining the same." Land, labour and capital are the best known
partial productivity measures. Total outputs as a ratio of some measures of labour quantity and provides some notion of output per worker is called labour productivity while land productivity is defined in terms of output per area of land (Weibe et al. 2003 and Zepeda 2001).

### 5.2 Measurement of Agricultural Productivity

The measurement of agricultural productivity is a difficult task because productivity varies from region to region due to different soil quality, climate differences, farmers' efforts, mechanization etc. the measurement of agricultural productivity refer to the inputs (either single input or a group of inputs) to the output (either total or a part of it) like yield per hectare, output per man hour, output per unit of capital. There are various scholars in India as well as in world who tried to measure the agricultural productivity.

In an earlier attempt while measuring the relative productivity of British and Danish farming, Thompson (1926) emphasized it in terms of gross output of crops and livestock. He selected seven parameters for it. They are i) the yield per acre of crops, ii) the livestock per 100 acres, iii) the gross agricultural production or output per 100 acres, iv) number of persons employed, v) the proportion of arable land, vi) the cost of production expressed in terms of wages and labour cost, rent or interest, and vii) prices relative profitability and general economic conditions.

In his study of the Ganga Valley, Ganguli (1938) presented a theoretical discussion for computing productivity in agriculture. First, he considered the area under any crop 'A' in a particular unit forming a part of certain region. This area is considered as a proportion of the total cropped area to all the selected crops. Secondly, he tried to obtain the crop yield index. This is found by dividing the yield per hectare for the entire region as the standard. This yield may be regarded as a percentage and the percentage may be expressed as the yield index number. Thirdly, the proportion of the area under ' A ' and the corresponding yield index number were multiplied. Thus, the obtaining product shows actually an index of the contribution of the crop A to the productivity of the unit considered.

Kendall (1939) regarded the crop productivity as a mathematical problem. He selected four years and four coefficients for the acre yield of ten leading crops in forty eight counties of England. These four coefficients are productivity coefficient, ranking coefficient, money value coefficient, and starch equivalent or energy coefficient. Kendall pointed out productivity coefficient as yield per acre. While determining the productivity coefficient, it requires advance mathematical calculation and practical difficulties also rise in determining the money and starch value coefficients. Therefore, Kendall considered ranking coefficients an easy method out of four coefficients. To calculate ranking coefficient, Kendall arranged the acre yield of selected ten crops in descending order in the each country. He averaged the rank of forty eight country (sum of the ranks occupied by the unit was divided the number of crops). Further, Kendall pointed out two units, one is for money value which is expressed in price and other is for energy which is indicated in starch unit. The money value coefficient is calculated by multiplying the volume of a particular crop production by the price and the results of selected crops for each country were added together and the total was divided by the total acreage of all selected crops in each country. The energy coefficient is based on energy index which was prepared by determining the production of energy per acre under crops on the basis of prepared table showing the energy value of various crops.

There are some major difficulties in determining the money value coefficients. The price data for certain crops are either not available or adequate and find significant differences in prices at a local region from the other part of the country due to some circumstances like, the proximity to the market the relative nutritive character of the product. Kendall suggested starch equivalent as the most suitable unit because it depends on nutritional factors which ignores local variations.

Hirsch (1943) recommended 'Crop Yield Index' as the basis of productivity measurement. It indicates the average of the yield of various crops on a farm or in a locality relative to the yield of the same crops on another farm or in a second locality. But this method is criticized because it measures only output and gives no information about inputs. Therefore it is no productivity measures. Zobel (1950) has attempted to determine the labour productivity. He considered the productivity of labour as the ratio of total
output to the total man-hours consumed in the production of that output resulting in output per man-hour.

Huntigaton and Valkenburg (1952) examined land productivity on the basis of acre yields of eight crops raised widely in Europe. They selected the average yield per acre of each crops for whole country and taken as an index of 100, and the specific yield in each country was calculated. Stamp (1952) adopted Kendall's ranking coefficients method on an international level in order to determine agricultural efficiency by selecting nine crops in the twenty countries of the world.

For measuring the agricultural productivity, L.D. Stamp (1958) considered calorific value of production in calories. He calculated the Standard Nutrition Unit (SNU) by converting all the food production per acre in calories. On the basis of available sources, The British Medical Association published a table which shows the range of caloric intake among adults from 2,100 a day for a woman in sedentary occupation to 4,250 for a man engaged in active manual work. The desirable intake is considered as 800 a day for infants less than one year and estimated 3,400 calories for teenage boys. By considering the age structure of the population, the range of occupation, the weight and height of the people living under the climatic conditions of the north Western Europe, the average calorie intake is 2,460 a day or about $9,00,000$ calories per year.

The Nutrition Expert Group of Indian Council of Medical Research has suggested the caloric intake for Indian and presented a table to show the calorie intake among adults from 1,900 a day for woman in sedentary work to 3,900 for a man engaged in manual work. It was suggested 110 calories per kg weight of the body per day for infants under one year to 3,000 for teenage boy. Shafi (1960) adopted Kendall' ranking coefficients method for measuring agricultural efficiency in the twelve villages of eastern Uttar Pradesh.

Loomis and Barton (1961) have calculated the agricultural inputs and aggregate productivity in United States. They considered agricultural productivity as measures of agricultural output and input. The measures of inputs include all the production factors that depend directly on the decisions of farmers. Meiburg and Brandt (1962) surveyed the
eight indices of agricultural production in the United States. Mackenzie (1962) has measured the efficiency of production in Canadian agriculture. Commen (1962) has measured trend of productivity in state of Kerala on the basis of yield per acre.

Enyedi (1964) delineated geographical types of agriculture in Hungary. He used the following formula for determining agricultural productivity:

$$
\frac{Y}{Y n}: \frac{T}{T n}
$$

Where,
$\mathrm{Y}=$ total yield of the respective crop in the unit area,
$\mathrm{Yn}=$ total yield of the crop at the national level,
$\mathrm{T}=$ total cropped area of the unit,
$\mathrm{Tn}=$ total cropped area at the national level

Horring (1964) has emphasized not only the single relationship between input and output but the concept of productivity explains the differences between two or more relationships, i.e. differences between the similar agricultural region in different regions during the same period or differences in the same agricultural region two or more successive periods. It may also be possible to make comparisons between the trends of productivity for different products, between different regions of the national economy or between the agricultural regions and the national economy as a whole. Chatterji and Maitreya (1964) have taken only two major crops, one is taken from the food crops i.e. rice and other is taken from the cash crop i.e. jute for determining the levels of agricultural development and productivity in the West Bengal during 1950-51 to 195758. They used the acre yield figure for this purpose. Garg (1964) worked out the trends in agricultural development with respect to total cropped area, gross irrigated area and foodgrain production in the two districts of Uttar Pradesh (Gorakhpur and Mirzapur) by assessing acreage, production and average yield per acre of three principal crops viz. rice, wheat and sugarcane during 1951-52 to 1960-61.

Gopalkrishnan and Ramakrishna (1964) measured the degree and causes of variation in each of twenty districts of Andhra Pradesh during the year of 1959-60. They selected two variables for measuring the degree of variation-1) agricultural output per
acre (Rs.), 2) output per head of agricultural population (Rs). The variables relating to the level of output per acre are selected as follows: (i) normal level of rainfall, (ii) percentage of current and old fallows, (iii) percentage of area under irrigation, (iv) percentage of literacy, (v)percentage of population engaged in agriculture, (vi) cropping intensity, (vii) percentage of gross value other than foodgrains and fodder, (viii) percentage of area under all crops excluding fodder and foodgrains, (ix) density of agricultural population per acre, and (x)percentage of total area under commercial crops including rice.

Sapre and Deshpande (1964) have modified the Kendall's ranking coefficient technique. They utilized the weighted average ranks of different crops instead of simple averaged ranks used by kendall. The average weight for ranks is calculated as multiply the ranks with percentage share of crops area to total cropped area. After it, the result is divided by the total percentage area of the crops. It can be better understand by the following example: if wheat occupies 40 percent of the total cropped area and it ranks 2 on the basis of wheat acre yield, rice occupies 25 percent of the total cropped area and attains rank 4 on the basis of rice acre yield and maize covers 12 percent to the total cropped area and attains 6 ranks on the basis of maize acre yield. Thus, the weighted average of the ranks would be: $(40 \mathrm{x} 2)+(25 x 4)+(12 x 6)=252$ divided by the sum of weights as $252 / 77=3.27$. According to Kendall simple average rank, it would be $2+4+6$ $=12$ divided by the number of crops $12 / 3=4$.

Khusro (1965) has assessed the concept of productivity with the output per unit of a single input and output per unit of cost of all inputs in the agricultural production. Saran (1965) has adopted the Cobb-Douglas 'Production Function' approach for the measurement of productivity. The purpose of this function is to express input output relationship between several inputs in the agricultural systems. Tambad (1965) has applied ‘Crop Yield Index’ for measuring agricultural productivity in Mysore state. The purpose of this technique is to express the average yield of various crops on a farm or in a region with the yield of same crops on another farm or in a second region. It can be represented by the following equation:
Crop Yield Index $=\frac{\sum_{\mathrm{i}=1}^{\mathrm{n}} \frac{Y i}{Y i o} A i}{\sum_{\mathrm{i}=1}^{\mathrm{n}} \quad A i}$

Where,
$\mathrm{i}=1,2,3 \ldots \ldots \ldots \ldots . \mathrm{n}$ are the number or crops considered in an unit area or year,
$Y i=$ yield per acre of crop i in a farm area or year,
$A i=$ weightage of crop $i$, denoted by the area under the crop as percentage of the total cropped,

Yio $=$ average yield per acre of crop $i$, at the group of farms, or entire region or year.

Shafi (1965) has measured the labour productivity and it can be computed by dividing the gross production in a unit area by the number of man hours or less precisely by the numbers engaged in agriculture. A reverse index is applied where the total number of workers per unit of production is assessed.

Agrwal (1965) has accepted the factorial approach for measuring agricultural efficiency in his study of Bastar district in Madhya Pradesh. He has selected a set of human controlled factors relating to agricultural production viz. crop superiority, crop commercialisation, crop security, land use intensity and power supply and he has excluded the environmental factors.

Bhatia (1967) has studied the changes and trends of agricultural efficiency in the districts of Uttar Pradesh during 1953-1963 by adopting Ganguli’s method. In his study, he assumed i) hectare yield express all the physical and human factors connected with the crop production and ii) the sharing of crop area among the various crops reflected various factors involved in land utilization. He developed an equation that may be expressed as follows:

$$
\text { Iya }=\frac{Y c}{C r} \times 100
$$

Where,
Iya $=$ yield index number of crop $a$,
$Y c=$ average yield crop a in the particular area,
= average yield of crop a in the entire region
And

$$
E i=\frac{I y a \times C a+I y b \times C b+\cdots+I y n \times C n}{C a+C b \ldots+C n}
$$

Where,
Ei = agricultural efficiency index,
Iya, Iyb....Iyn = yield indices of various crops, and
$\mathrm{Ca}, \mathrm{Cb} . \ldots . . \mathrm{Cn}=$ percentage of crop land under the different crops.
E de Vries (1967) has modified the Buck's grain equivalent method. He expressed all outputs of grains in terms of milled rice equivalent per head of total population in Asian countries. Clark and Haswell (1967) have modified both the method given by Buck and E de Vries and he expressed the output in terms of 'wheat equivalent' per person.

Noort (1967) has measured the productivity in terms of net total productivity. The net total productivity refereed to the relationship between the net product and factor product. The purpose of this method is to analysis the changes in labour and capital inputs in agriculture.

Sinha (1968) has accepted a standard deviation formula for determining agricultural efficiency in India. He has taken all the twenty five crops which were grown in the country. He categorized these major crops into cereals, pulses, oilseeds and cash crops and took the specific yields per hectare of cereals, pulses and oilseed. The monetary value of cash crops were calculated (in Rs.) per hectare by incorporating wholesale market prices. The standard score were computed and to give them weightage, these values of standard score were multiplied by the area of cultivation under the crops.

Shafi (1972) modified the Enyedi's formula for measuring the agricultural productivity of the Great Plains of India. The modified formula can be read as follows:

$$
\left(\frac{y w}{t}+\frac{y r}{t}+\frac{y m i}{t} \ldots \ldots . n\right):\left(\frac{Y t}{T}+\frac{Y r}{T}+\frac{Y m i}{T} \ldots . n\right)
$$

Where,
yr, ymi......n = total yield of various crops in the district,
Yw, Yr, Ymi.....n = total yield of the various crops at the national level,
$\mathrm{t}=$ total area under different crops in the district,
$\mathrm{T}=$ total area under different crops at the national level.

Singh (1972) has tried to measure the agricultural efficiency in terms of nutrition units per unit area in his study of Haryana. He measured the carrying capacity per square mile in the area unit which can express as:

$$
\mathrm{Cp}=\frac{C o}{S n}
$$

Where,
Cp = carrying capacity,
$\mathrm{Co}=$ caloric output per square mile,
$\mathrm{Sn}=$ standard nutrition for ingestion in calories per annum.

To obtain index numbers, Singh measured the percentage of carrying capacity in the entire region which gives a measure of the agricultural efficiency of the areal unit relative to the entire region. It can be expressed as:

$$
\text { Iae }=\frac{C p e}{C p r} \times 100
$$

Where,
Iae $=$ index number of agricultural efficiency of an enumeration unit,
Cpe $=$ the carrying capacity in terms of population in the component enumeration unit,
$\mathrm{Cpr}=$ the carrying capacity in the entire region.

Jasbir Singh (1976) has assessed the regional differences in the level of food production and has paid a greater attention on important food crops lying in the Oriental World. To measure the level of agricultural productivity, the relative crop yield and
concentration indices are arranged in ranking order and computed into average ranking coefficient which may be called the crop yield and concentration indices ranking coefficient. The equation may be expressed as:

$$
\mathrm{Yi}=\frac{Y a c}{Y a r} \times 100
$$

Where,
Yi = crop yield index,
Yac = average yield per hectare of crop ' $a$ ' in the component enumeration unit,
Yar = average yield of crop ' $a$ ' in the entire region or country
and

$$
\mathrm{Ci}=\frac{P a c}{P a r} \times 100
$$

Where,
$\mathrm{Ci}=$ crop concentration index,
Pac = percentage strength of crop ' $a$ ' in the total harvested area in the component enumeration unit

Par $=$ percentage strength of crop ' $a$ ' in the total harvested area in the entire region or country.

The crop yield concentration indices ranking coefficient can be obtained by adding the yield and concentration ranks for individual crops and then divide by 2 . The equation for it may be expressed as:
Crop yield and
concentration indices $=$

ranking coefficient for crop ' a ' \begin{tabular}{l}
Crop yield index <br>
ranking of crop ' $a$ '

 

Crop concentration index <br>
ranking of crop 'a'
\end{tabular}

The obtain result from this equation five the idea of the level of agricultural productivity means lower ranking coefficient, the higher the level of agricultural productivity and vice versa.

Bhalla (1978) has considered nineteen crops while measuring productivity of labour in each district of India during the trienniums 1962-65 and 1970-73 and he has considered output per person on constant average price for measuring labour productivity.

Jasbir Singh and Sharma (1985) have attempted to modify the Clark and Haswell 'Wheat equivalent’ system. He used labour productivity expressing as gross agricultural output in conventional grain units per hectare of cropped area or per person engaged in agriculture where gross agricultural output in rupees has been divided by the wheat support price for conversion into conventional grain units.

Dharmasiri (2009) have used the 'Average Productivity Index' in Nuwaraliya district of Sri Lanka. Ha has taken two variables for his study viz. yield and harvested area of the selected crops at a state or country level.

Various researchers who have applied different methods for measuring the agricultural productivity but W.Y.Yang (1965) has used the 'Crop Yield Index' for assessing the agricultural productivity. It considers the yield of all crops in a farm computed with the average yield of crops in the region. Then calculate the crop yield in the farm as percentage to the region and obtained value is multiplied by the area of each crops in the farm. By adding all values obtained by this was divided by the sum of the area occupied by each crops in the farm. Finally, average desired crop index is obtained for any particular farm.

To achieve self sufficiency in agricultural production, it is necessary to assess the agricultural productivity at a micro level in every region of the country. Therefore, to measure the agricultural productivity at micro level in Aligarh district, Yang’s crop yield index method has been applied for the two study periods of 1996-97 and 2011-12. For calculating all major crops in the study area, they are grouped into four major groups:

1) Cereals which include rice, wheat, barley, millet and maize,
2) Pulses include arhar, moong, masur, urad, gram and pea,
3) Oilseeds including mustard
4) Cash crops comprise sugarcane and potato

Then a composite index has been prepared by combining all the major groups of crops. Here, a table 5.1 for crop yield index has been calculated for Tappal block in Aligarh district. For calculating it, the average yield of each crop is taken. Then the percentage value of the crop yield in the Tappal block is calculated by dividing the yield
per hectare of the crops in Aligarh district. This value gives the index number of the crop yield in the block is multiplied by the area under the crops in Tappal block. Then obtained values are added and divide by the sum of total area of selected crops. Therefore, the desired crop index is prepared to measure the agricultural productivity.

Table 5.1
Method of Calculating Crop Yield Index for Tappal block, Aligarh (2011)

|  | Area of <br> crops in <br> the <br> block <br> (in ha.) | Yield in quintal per <br> hectare | Yield in <br> the <br> blocks | Average <br> yield in <br> the <br> Cistrict | Crop yield in <br> the block as \% <br> to the district |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Percentage <br> multiplied <br> by area in <br> hectare |  |  |  |  |  |
| 1 | 2 | 3 | 4 | $5=$ Col.3/ <br> Col.4*100 | $6=$ Col.5 * <br> Col.2 |
| Rice | 6703 | 20.92 | 22.05 | 94.86453 | 635876.9 |
| Wheat | 25927 | 40.1 | 37.50 | 106.9286 | 2772337 |
| Barley | 632 | 35.79 | 35.51 | 100.7885 | 63698.34 |
| Millet | 5184 | 19.36 | 19.46 | 99.50317 | 515824.4 |
| Maize | 517 | 21.36 | 19.64 | 108.7715 | 56234.86 |
| Total | $\mathbf{3 8 9 6 3}$ |  |  |  | $\mathbf{4 0 4 3 9 7 2}$ |

Crop Yield Index for Tappal block $=4043972 / 38963$

$$
\text { = } 103.79 \text { per cent }
$$

### 5.3 Agricultural Productivity Regions: Based on Yang's Crop Yield Index

On the basis of Yang's yield index method, all the blocks of Aligarh district have been classified into three categories i.e. high, medium and low. The productivity region of crops has been discussed below:

## Productivity Regions - Cereals (1996-97)

Cereals constitute an important position in agriculture sector in India as well as in the study region. They occupied an area of 348317 hectares accounting about 77.76 per cent of the total cropped area. It is seen from the table 5.2 that the productivity indices vary from the lowest value of 93.18 in Iglas block to a highest index value of 107.75 in Tappal block during 1996-97.

Table 5.2

## Crop Yield Index computed on the basis of Yang's Yield Index method

 in Aligarh District (1996-97)| Blocks/ <br> Crops | Cereals | Pulses | Oilseeds | Cash <br> Crops | Composite <br> Index |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Tappal | 107.75 | 102.35 | 103.42 | 118.45 | 107.99 |
| Khair | 99.41 | 94.15 | 94.22 | 96.75 | 96.13 |
| Chandaus | 100.83 | 98.61 | 88.26 | 107.37 | 98.77 |
| Jawan | 105.88 | 113.56 | 109.38 | 101.46 | 107.57 |
| Lodha | 103.47 | 91.98 | 101.12 | 90.30 | 96.72 |
| Dhanipur | 102.72 | 103.19 | 101.62 | 90.17 | 99.43 |
| Akrabad | 96.98 | 94.88 | 118.94 | 116.68 | 106.87 |
| Gonda | 96.75 | 97.41 | 93.07 | 96.20 | 95.86 |
| Iglas | 93.18 | 95.84 | 98.75 | 117.95 | 101.43 |
| Atrouli | 105.58 | 114.65 | 100.76 | 98.90 | 104.97 |
| Bijouli | 99.43 | 99.82 | 96.52 | 94.81 | 97.65 |
| Gangiri | 94.14 | 93.55 | 93.96 | 98.49 | 95.03 |
| Sorce: Based |  |  |  |  |  |

Source: Based on Data obtained from Directorate of Agriculture, Aligarh
Table 5.3
Category of Cereals Yield Index in Aligarh District (1996-97)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above102.86 | 4 | Tappal, Jawan, Lodha, Atrouli |
| Medium | $98.16-102.86$ | 4 | Khair, Chandaus, Dhanipur, Bijouli |
| Low | Below 98.16 | 4 | Akrabad, Gonda, Iglas, Gangiri |

Source: Computed by researcher based on table 5.2

Figure 5.1 shows that high productivity of cereals has been found in four blocks namely, Tappal, Jawan, Lodha and Atrouli with index value above 102.86. The region of high productivity of cereals lies in the northern part of the Aligarh district. The medium productivity of cereals has been noticed in Khair, Chandaus, Dhanipur and Bijouli
whereas remaining four blocks (Akrabad, Gonda, Iglas and Gangiri) fall under low category with an index value of below 98.16. The area under low category constitutes the southern part of the study area.

## Productivity Regions - Pulses (1996-97)

During 1997-97, pulses are the main source of protein. After cereals, pulses occupied 9.48 per cent of the cropped area of the region. It is clear from the table 5.2 that the highest productivity of pulses has been found in Atrouli block (114.65) followed by Jawan block (113.56). The low productivity of pulses has been observed in five blocks, i.e. Khair, Lodha, Akrabad, Iglas and Gangiri. Remaining five blocks fall under the medium productivity of pulses (Figure 5.2).

Table 5.4
Category of Pulses Yield Index in Aligarh District (1996-97)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 103.71 | 2 | Jawan, Atrouli |
| Medium | $96.29-103.72$ | 5 | Tappal, Chandaus, Dhanipur, Gonda, <br> Bijouli |
| Low | Below 96.29 | 5 | Khair, Lodha, Akrabad, Iglas, Gangiri |

Source: Computed by researcher based on table 5.2

## Productivity Regions - Oilseeds (1996-97)

During 1996-97, Oilseeds account 9.14 percent area to the total cropped area in the region. It is clear from the table 5.3 that there are only two blocks namely, Jawan and Akrabad which fall under the high productivity region of oilseed with index value of above 104.68. Six blocks out of the total twelve blocks fall under medium category with the index value ranging between 95.92 and 104.08. These six blocks are Tappal, Lodha, Dhanipur, Iglas, Atrouli and Bijouli. Remaining four blocks i.e. Khair, Chandaus, Gonda and Gangiri are low productivity region of oilseeds with an index value of below 95.92 (Figure 5.3).


Figure 5.1


Figure 5.2


Figure 5.3


Figure 5.4

Table 5.5
Category of Oilseeds Yield Index in Aligarh District (1996-97)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 104.08 | 2 | Jawan, Akrabad |
| Medium | $95.92-104.08$ | 6 | Tappal, Lodha, Dhanipur, Iglas, Atrouli, |
| Bijouli |  |  |  |
| Low | Below 95.92 | 4 | Khair, Chandaus, Gonda, Gangiri |

Source: Computed by researcher based on table 5.2

## Productivity Regions - Cash crops (1996-97)

There are two crops (sugarcane and potato), considered in cash crops in the study region. Cash crops account 3.62 percent of the total cropped area. Table 5.6 shows that the highest productivity has been recorded in Tappal block having 118.45 whereas Dhanipur has lowest productivity of cash crops having index value of 90.17. It is seen from the fig. 5.4 that the high productivity of cash crops has been concentrated in three blocks i.e. Tappal, Akrabad and Iglas. Whereas low productivity region spread over five blocks i.e. Khair, Lodha, Dhanipur, Gonda and Bijouli. Remaining four blocks fall under medium productivity region of cash crops (Figure 5.4).

Table 5.6
Category of Cash Crops Yield Index in Aligarh District (1996-97)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 107.47 | 3 | Tappal, Akrabad, Iglas |
| Medium | $98.38-107.47$ | 4 | Chandaus, Jawan, Atrouli, Gangiri |
| Low | Below 97.12 | 5 | Khair, Lodha, Dhanipur, Gonda, Bijouli |

Source: Computed by researcher based on table 5.2

## Productivity Regions-Composite Yield Index (1996-97)

Finally, an attempt has been made to sum up the variations of the crops for getting composite value index. The composite yield index for the year 1996-97 has been shown


Figure 5.5
in the table 5.7. It is seen from figure 5.5 that there are four blocks namely, Tappal, Jawan, Akrabad, and Atrouli which record high productivity of crops whereas low productivity regions cover four blocks i.e. Khair, Lodha, Gonda and Gangiri. Remaining four blocks (Chandaus, Dhanipur, Bijouli and Iglas) come under the medium productivity regions.

Table 5.7
Category of Composite Yield Index in Aligarh District (1996-97)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 104.53 | 4 | Tappal, Jawan, Akrabad, Atrouli |
| Medium | $96.87-104.53$ | 4 | Chandaus, Dhanipur, Iglas, Bijouli |
| Low | Below 96.87 | 4 | Khair, Lodha, Gonda, Gangiri |

Source: Computed by researcher based on table 5.2

Table 5.8
Crop Yield Index computed on the basis of Yang's Yield Index method in Aligarh District (2011-12)

| Blocks/ <br> Crops | Cereals | Pulses | Oilseed | Cash <br> crops | Composite <br> index |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Tappal | 103.79 | 98.10 | 96.63 | 102.22 | 100.19 |
| Khair | 100.15 | 94.22 | 100.83 | 98.84 | 98.51 |
| Chandaus | 100.46 | 99.30 | 102.73 | 89.74 | 98.06 |
| Jawan | 102.80 | 104.37 | 104.26 | 98.89 | 102.58 |
| Lodha | 103.70 | 104.87 | 105.02 | 91.55 | 101.28 |
| Dhanipur | 103.65 | 96.83 | 95.95 | 99.28 | 98.93 |
| Akrabad | 101.82 | 103.87 | 104.11 | 95.99 | 101.45 |
| Gonda | 96.83 | 101.19 | 97.55 | 103.74 | 99.82 |
| Iglas | 96.05 | 99.59 | 96.48 | 131.63 | 105.94 |
| Atrouli | 103.96 | 109.84 | 105.71 | 113.73 | 108.31 |
| Bijouli | 98.36 | 99.30 | 103.57 | 97.48 | 99.68 |
| Gangiri | 96.19 | 90.74 | 87.17 | 94.00 | 92.03 |

Source: Based on Data obtained from Directorate of Agriculture, Aligarh

## Productivity regions- Cereals (2011-12)

Rice is the fastest growing crop among cereals in the year of 2011-12. Cereals cover an area of 415942 hectare accounting 86.78 percent to the total cropped area of the region. It is seen from the table 5.9 that during 2011-12, the highest productivity of cereals has been found in Atrouli (103.96) while lowest productivity region of cereals is Iglas (96.05). It is evident from the figure 5.6 that high productivity region of cereals cover five blocks namely, Tappal, Jawan, Lodha, Dhanipur, and Atrouli having index value above 102.20.

Table 5.9
Category of Cereals Yield Index in Aligarh District (2011-12)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 102.20 | 5 | Tappal, Jawan, Lodha, Dhanipur, Atrouli |
| Medium | $99.09-102.20$ | 3 | Khair, Chandaus, Akrabad, |
| Low | Below 99.09 | 4 | Gonda, Iglas, Bijouli, Gangiri |

Source: Computed by researcher based on table 5.8

The areas marked with medium productivity of cereals have been found in three blocks i.e. Khair, Chandaus, and Akrabad. The low productivity region of cereals scatter over four blocks of the district i.e. Gonda, Iglas, Bijouli, and Gangiri.

## Productivity regions- Pulses (2011-12)

During 2011-12, pulses covered 15149 hectares ( 3.22 percent) area of the total cropped area. Table 5.8 shows that he highest productivity of pulses has been observed in Atrouli block and the lowest productivity has been registered in Gangiri block. It is observed from the figure 5.7 that there are four blocks namely, Jawan, Lodha, Akrabad, and Atrouli which come under the high productivity regions of pulses whereas low productivity regions cover three blocks i.e. Khair, Dhanipur, and Gangiri. Remaining five blocks register medium productivity regions of pulses.

Table 5.10
Category of Pulses Crops Yield Index in Aligarh District (2011-12)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 102.75 | 4 | Jawan, Lodha, Akrabad, Atrouli |
| Medium | $97.62-102.75$ | 5 | Tappal, Chandaus, Gonda, Iglas, Bijouli |
| Low | Below 97.62 | 3 | Khair, Dhanipur, Gangiri |

Source: Computed by researcher based on table 5.8

## Productivity regions- Oilseeds (2011-12)

Oilseed covered an area of 17658 hectares ( 3.68 percent) to the total cropped area of the region in the year of 2011-12. It is clear from the table 5.11 and figure 5.8 that there are six blocks namely, Chandaus, Jawan, Lodha, Akrabad, Atrouli and Bijouli which record high productivity of oilseeds with index value of above 102.72. There are only two blocks i.e. Khair and Gonda which come under the medium productivity region of oilseeds. The remaining four blocks place under the low productivity regions of oilseeds with the index value below 97.28. It is observed that the productivity of oilseeds has been reduced due to low benefits.

Table 5.11
Category of Oilseeds Yield Index in Aligarh District (2011-12)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 102.72 | 6 | Chandaus, Jawan, Lodha, Akrabad, <br> Atrouli, Bijouli |
| Medium | $97.28-102.72$ | 2 | Khair, Gonda |
| Low | Below 97.28 | 4 | Tappal. Dhanipur, Iglas, Gangiri |

Source: Computed by researcher based on table 5.8

## Productivity regions- Cash Crops (2011-12)

Cash crops covered an area of 30285 hectares accounting 6.32 percent of the total cropped area of the region and constitute the second ranking crops in 2011-12. The highest productivity of cash crop has been found in Iglas (131.63) followed by Atrouli (113.73) and whereas lowest productivity has been recorded in Chandaus (89.74)


Figure 5.6


Figure 5.7


Figure 5.8


Figure 5.9


Figure 5.10
followed by Lodha (91.55) and Gangiri (94.00). Remaining seven blocks i.e. Tappal, Khair, Jawan, Dhanipur, Akrabad, Gonda, and Bijouli come under medium productivity regions of cash crops (figure 5.9).

Table 5.12
Category of Cash Crops Yield Index in Aligarh District (2011-12)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 107.11 | 2 | Iglas, Atrouli |
| Medium | $95.74-107.11$ | 7 | Tappal, Khair, Jawan, Dhanipur, <br> Akrabad, Gonda, Bijouli |
| Low | Below 95.74 | 3 | Chandaus, Lodha, Gangiri |

Source: Computed by researcher based on table 5.8

## Productivity regions- Composite Yield Index (2011-12)

The composite yield index for the year 2011-12 is shown in the figure 5.10. It is evident from the table 5.13 and figure 5.10 that the high productivity regions based on composite index include two blocks namely, Iglas and Atrouli with the index range above 102.60. The high productivity is due to adequate irrigation facilities and high concentration of agricultural machineries. The medium productivity regions covered seven blocks i.e. Tappal, Jawan, Lodha, Dhanipur, Akrabad, Gonda, and Bijouli. The remaining three blocks belonging to low productivity regions are Khair, Chandaus, Gangiri with index value of below 98.53. It is observed from the table 5.8 that Atrouli has high productivity in all groups of crops due to agricultural innovations whereas Gangiri has low productivity in all groups of crops due to low mechanization.

Table 5.13
Category of Composite Yield Index in Aligarh District (2011-12)

| Category | Indices | No. of Blocks | Name of the block |
| :---: | :---: | :---: | :---: |
| High | Above 102.60 | 2 | Iglas, Atrouli |
| Medium | $98.53-102.60$ | 7 | Tappal, Jawan, Lodha, Dhanipur, <br> Akrabad, Gonda, Bijouli |
| Low | Below 98.53 | 3 | Khair, Chandaus, Gangiri |

Source: Computed by researcher based on table 5.8

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## CHAPTER-6

LEVELS OF
AGRICULTURAL DEVELOPMENI

Agricultural development is the manifestation of the combined effects of physical, technological, institutional and infrastructural factors. The term agricultural development refers to the growth and overall changes of agriculture resulting in vertical expansion. Therefore, the level of agricultural development may be considered as the degree to which agrarian structure gets strengthened leading thereby to increased population. Agricultural productivity is one of the dimensions of agricultural development. In true sense, agricultural development denotes the quality of agricultural system of regions in terms of productivity, diversification and commercialization (Gopal Krishnan, 1992). The development is a positive concept which aims at enhancing the level of the living of the people and general condition of human welfare in a region. The purpose of agricultural development is aimed at reducing the regional disparities existing in a particular to minimum and to find out the possible means for the development the region as a whole. The level and rate of agricultural development represents a picture prevailing at a particular point of time and achieved progress over a given period. If the process of agricultural development is regulated on systematic lines, it becomes agricultural development planning. Nath (1969) constructed the composite index of agricultural development in India based on three factors i.e. growth rate of agricultural output, use of modern inputs in agriculture and productivity per hectare. Alam (1974) in his study of regional disparities in Andhra Pradesh, applied six indicators for the agricultural sector. Two of these are related to productivity in terms of per agricultural worker and per acre and four are related to irrigation and cropped area. Rajapati Ram (1989) used agrotechnical determinants like irrigation, fertilizers, High Yielding Varieties of seeds, agricultural mechanization and others to measure the level of agricultural development of a region.

Therefore, to understand the level of agricultural development, a scientific investigation is necessary for future orientation of agricultural planning. Keeping these views in mind, the level of agricultural development is studied in twelve blocks of Aligarh district to evolve a sound base for future agricultural planning.

In Aligarh district, the level of agricultural development has been assessed in three ways: first, the correlation matrix among the selected variables during the period 1996-97 and 2011-12 has been explained. Secondly, factor analysis technique has been used to determine the actual role of selected variables of agricultural development. Thirdly, an attempt has been made to determine the level of agricultural development with the help of composite z-score. The author has selected twenty-two variables for analyzing the level of agricultural development.

## Correlation Matrix

Correlation matrix has been analysed by Carl Pearson's Principal Component Matrix. It is a method for expressing information in an alternative form which is often more succinct than the original (Jackson, 1983). The purpose of this technique is to explain the relationship among twenty-two variables of agriculture development.

## Inter-relationship among variables (1996-97)

Table 6.2 shows that the variable agricultural productivity is significantly positively correlated with soil nutrient (0.690), canal length (0.642), tube-wells (0.620), and pump-sets (0.581) and it is also positively correlated with cropping intensity (0.415), percentage of net irrigated area to gross irrigated area (0.353), number of tractors (0.304), cooperative societies (0.287), literate population (0.249) and percentage of net irrigated area to net sown area (0.145). A high negative correlation has been marked between agricultural productivity and advance harrow and cultivators i.e. -0.690 . The soil quality plays a significant role in maintaining agricultural productivity. If soil quality is low, yield is also low. The advance technology of agriculture led to soil infertile, therefore, agricultural productivity is not increasing as it should be.

When percentage of literate population to total population $\left(\mathrm{X}_{2}\right)$ is correlated with other variables, it shows that it is significantly positively correlated with percentage of net irrigated area to net sown area $(0.829)$ followed by advance harrow and cultivators ( 0.727 ) and advance sowing machines ( 0.582 ) and the high negative correlation is shown with wooden plough $(-0.840)$ and area under grains on gross sown area $(-0.836)$.

Table 6.1
Selected Variables of Agricultural Development in Aligarh District

| Variables | Variables explained |
| :---: | :--- |
| $\mathrm{X}_{1}$ | Agricultural Productivity based on Yang’s Yield Index method |
| $\mathrm{X}_{2}$ | Percentage of literate persons to total population |
| $\mathrm{X}_{3}$ | Percentage of agricultural workers to total workers |
| $\mathrm{X}_{4}$ | Percentage of area under food grains to gross cropped area |
| $\mathrm{X}_{5}$ | Consumption of fertilizers (in kg/hectares) to gross cropped area |
| $\mathrm{X}_{6}$ | Percentage of net irrigated area to gross irrigated area |
| $\mathrm{X}_{7}$ | Percentage of net irrigated area to net sown area |
| $\mathrm{X}_{8}$ | Cropping intensity (\%) |
| $\mathrm{X}_{9}$ | Soil nutrients (\%) |
| $\mathrm{X}_{10}$ | Number of tractors on per 10,000 hectare of gross cropped area |
| $\mathrm{X}_{11}$ | Number of advance harrow and cultivators on per 10,000 hectare of gross <br> cropped area <br> $\mathrm{X}_{12}$ |
| $\mathrm{X}_{13}$ | Number of advance thrasher machines on per 10,000 hectare of gross <br> cropped area |
| $\mathrm{X}_{14}$ | Number of sprayers on per 10,000 hectare of gross cropped area <br> cropped area |
| $\mathrm{X}_{15}$ | Number of wooden ploughs on per 10,000 hectare of gross cropped area |
| $\mathrm{X}_{16}$ | Number of iron ploughs on per 10,000 hectare of gross cropped area |
| $\mathrm{X}_{17}$ | Number of pump-sets on per 10,000 hectare of gross cropped area |
| $\mathrm{X}_{18}$ | Canal length in kilometers on per 10,000 hectares of gross cropped area |
| $\mathrm{X}_{19}$ | Percentage of gross irrigated area on net irrigated area by total tube-wells |
| $\mathrm{X}_{20}$ | Number of primary agricultural cooperative societies per lakh of population |
| $\mathrm{X}_{21}$ | Percentage of electrified villages to total villages in population |
| $\mathrm{X}_{22}$ | Length of total pakki roads per lakh of population(in kilometers) |

Table: 6.2

Correlation Matrix of Twenty-Two Variables of Agricultural Development (1996-97)

| Variables | $\mathrm{X}_{1}$ | $\mathrm{X}_{2}$ | $\mathrm{X}_{3}$ | $\mathrm{X}_{4}$ | $\mathrm{X}_{5}$ | $\mathrm{X}_{6}$ | $\mathrm{X}_{7}$ | $\mathrm{X}_{8}$ | $\mathrm{X}_{9}$ | $\mathrm{X}_{10}$ | $\mathrm{X}_{11}$ | $\mathrm{X}_{12}$ | $\mathrm{X}_{13}$ | $\mathrm{X}_{14}$ | $\mathrm{X}_{15}$ | $\mathrm{X}_{16}$ | $\mathrm{X}_{17}$ | $\mathrm{X}_{18}$ | $\mathrm{X}_{19}$ | $\mathrm{X}_{20}$ | $\mathrm{X}_{21}$ | $\mathrm{X}_{2}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{X}_{1}$ | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{2}$ | 0.249 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{3}$ | -0.168 | -0.324 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{4}$ | -0.168 | -0.836** | 0.327 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{5}$ | 0.291 | -0.002 | -0.314 | -0.139 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{6}$ | 0.353 | -0.171 | -0.211 | 0.285 | 0.129 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{7}$ | 0.145 | 0.829** | -0.181 | -0.551 | -0.275 | -0.110 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{8}$ | 0.415* | -0.536 | -0.118 | 0.524 | 0.190 | 0.885** | -0.439 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{9}$ | 0.690* | 0.443 | -0.344 | -0.403 | -0.090 | 0.129 | 0.271 | -0.110 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{10}$ | 0.304 | 0.532 | 0.104 | 0.585* | -0.031 | -0.499 | 0.356 | 0.739** | 0.480 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{11}$ | -0.690* | 0.727** | 0.359 | 0.668* | -0.105 | -0.169 | -0.392 | 0.202 | -0.562 | 0.695* | 1 |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{12}$ | -0.363 | 0.149 | 0.077 | -0.085 | 0.048 | -0.339 | -0.127 | -0.205 | -0.544 | 0.510 | 0.241 | 1 |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{13}$ | -0.090 | 0.530 | -0.500 | -0.663* | 0.267 | -0.463 | 0.324 | -0.518 | -0.088 | 0.326 | -0.359 | 0.348 | 1 |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{14}$ | 0.006 | 0.582* | 0.024 | -0.571 | 0.418 | -0.467 | 0.460 | -0.670* | 0.064 | 0.719** | -0.373 | 0.090 | 0.487 | 1 |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{15}$ | -0.022 | -0.840** | 0.320 | 0.774** | -0.183 | 0.34 | -0.681* | 0.635* | -0.432 | -0.723** | 0.484 | 0.183 | -0.552 | -0.741** | 1 |  |  |  |  |  |  |  |
| $\mathrm{X}_{16}$ | 0.054 | -0.587* | 0.294 | 0.479 | -0.008 | 0.472 | -0.357 | 0.722** | -0.339 | -0.655* | 0.419 | 0.084 | -0.397 | -0.554 0 | 0.743** | 1 |  |  |  |  |  |  |
| $\mathrm{X}_{17}$ | 0.581* | 0.167 | 0.251 | -0.340 | -0.054 | -0.196 | -0.006 | -0.386 | 0.008 | 0.496 | -0.262 | 0.362 | 0.043 | 0.388 | -0.287 | $-0.500$ | 1 |  |  |  |  |  |
| $\mathrm{X}_{18}$ | 0.642* | -0.008 | -0.185 | 0.092 | -0.068 | 0.483 | -0.100 | 0.242 | 0.181 | -0.015 | -0.314 | -0.070 | -0.322 | -0.136 | 0.026 | -0.344 | 0.578* | 1 |  |  |  |  |
| $\mathrm{X}_{19}$ | 0.620* | 0.025 | 0.065 | 0.023 | 0.075 | 0.726** | 0.076 | -0.545 | -0.133 | 0.209 | 0.201 | 0.083 | 0.359 | 0.355 | -0.088 | -0.105 | -0.415 | -0.735** | 1 |  |  |  |
| $\mathrm{X}_{20}$ | 0.287 | 0.307 | 0.363 | 0.444 | 0.438 | 0.175 | -0.388 | 0.359 | -0.513 | -0.319 | 0.404 | 0.066 | -0.450 | -0.330 | 0.411 | 0.282 | 0.234 | 0.264 | -0.399 | 1 |  |  |
| $\mathrm{X}_{21}$ | 0.349 | 0.262 | -0.213 | -0.487 | 0.024 | 0.299 | 0.545 | -0.084 | 0.205 | 0.457 | -0.795** | -0.526 | -0.066 | 0.372 | -0.474 | 0.566* | 0.528 | 0.318 | 0.516 | -0.419 | 1 |  |
| $\mathrm{X}_{22}$ | -0.020 | 0.460 | -0.223 | 0.031 | -0.031 | 0.436 | -0.248 | 0.628* | -0.128 | -0.686* | 0.123 | 0.179 | -0.094 | -0.636* | 0.529 | 0.364 | -0.351 | -0.093 | -0.306 | -0.231 | $-0.150$ | 1 |

Source: Computed by Researcher

The variable percentage of agricultural workers to total workers $\left(\mathrm{X}_{3}\right)$ has no significant relationship with any other variables of agricultural development. It has partial positive correlation with area under grains, advance harrow and cultivators, ploughs, pump-sets and has negative partial correlation with fertilizers, soil nutrient and sprayers.

The percentage of area under grains to gross cropped area $\left(\mathrm{X}_{4}\right)$ is significantly positively correlated with wooden ploughs (0.774), advance harrow and cultivators ( 0.668 ) and tractors ( 0.585 ). The partial positive correlation is associated with cropping intensity (0.524), iron plough (0.479) and cooperative societies (0.444). It has highest negative correlation with literate population ( -0.836 ) followed by sprayers ( -0.663 ), tractors $(-0.585)$, advance sowing machines $(-0.571)$, net irrigated area to net sown area $(-$ 0.551 ) and has also negative partial correlation with soil quality, fertilizers, pump-sets and electrified villages.

The variable fertilizer consumed by per hectare of gross cropped area (X5) has neither high positive correlations nor high negative correlations with other variables. It is positively correlated with net irrigated area, cropping intensity, advance thresher machines, advance sowing machines, canal and tube-wells and is negatively correlated with other variables.

The variable percentage of net irrigated area to gross irrigated area $\left(\mathrm{X}_{6}\right)$ has only highly strong positive correlation with cropping intensity (0.885) and the highest negative correlation is associated with gross irrigated area by tube-wells ( -0.726 ). Rests of variables have insignificant positive and negative correlation with it. The percentage of net irrigated area to net sown area $\left(\mathrm{X}_{7}\right)$ is significant positively correlated with literate population (0.829) and is highly negatively correlated with wooden plough ( -0.681 ) followed by percentage area under grains (-0.551).

The variable cropping intensity ( $\mathrm{X}_{8}$ ) is significantly positively correlated with percentage of net irrigated area to gross irrigated area (0.885), iron plough (0.722), wooden plough (0.635) and length of total pakki roads (0.628). It is highly negatively correlated with tractors (-0.739) followed by advance sowing machines ( -0.670 ).

It is observed that a variable soil nutrient (X9) is highly positively correlated with agricultural productivity (0.690). It is positively correlated with irrigated area, literate persons, number of tractors, number of pump-sets, canal length and advance sowing machines. Remaining variables (agricultural workers, fertilizers consumption, advance harrow and cultivators and advance thresher machines) are negatively correlated with soil nutrients. It shows that advance instruments of agriculture loss soil fertility.

The variable number of tractors per ten thousands on gross sown area $\left(\mathrm{X}_{10}\right)$ is significantly positively correlated with cropping intensity (0.739), advance sowing machines (0.719), advance harrow and cultivators (0.695) and area under food grains (0.585) and is negatively correlated with wooden plough ( -0.723 ), electrified villages (0.686 ) and iron plough ( -0.655 ). Taking advance harrow and cultivators ( $\mathrm{X}_{11}$ ) for correlation with other variables, it is significantly positively correlated with literate persons (0.727), tractors (0.695) and percentage of area under food grains (0.668). The highest negative correlation is shown with two variables i.e. electrified villages (-0.795), and productivity (-0.690). The variable advance thresher machines ( $\mathrm{X}_{12}$ ) indicates that no variable is significantly positively or negatively correlated with thresher machines. The variable sprayers $\left(\mathrm{X}_{13}\right)$ is highly negatively correlated with grains area ( -0.663 ) followed by wooden plough ( -0.552 ) while it is positively correlated with variable literate population, fertilizers, tractors, thresher machines, sowing machines, and tube-wells. The variable advance sowing machines ( $\mathrm{X}_{14}$ ) shows that it is strong positively related with tractors (0.719) followed by literate persons (0.582) while it is highly negatively correlated with wooden plough ( -0.741 ), cropping intensity ( -0.670 ), length of total pakki roads $(-0.636)$, area under food grains $(-0.571)$ and iron plough $(-0.554)$.

It is observed that the variable wooden plough ( $\mathrm{X}_{15}$ ) is significant correlated with area under grains $(0.774)$, iron plough ( 0.743 ) and cropping intensity ( 0.635 ). The use of wooden plough is strongly negatively correlated with literate population (-0.840), advance sowing machines ( -0.741 ), tractors ( -0.723 ) and cropping intensity ( -0.681 ) and sprayers (-0.552). It clears that literate population do not use wooden plough but they use modern agriculture tools. On the other hand, if we see the correlation of iron plough ( $\mathrm{X}_{16}$ ) with other variables, it is strongly positively correlated with wooden plough
followed by cropping intensity ( 0.722 ) and canal length ( 0.664 ) while it is negatively correlated with pump-sets (-0.655), literate population (-0.587) and sowing machines (0.554 ).

The use of pump-sets ( $\mathrm{X}_{17}$ ) is positively correlated with productivity ( 0.581 ) and canal length (0.578). The partial positive correlation of pump-sets is associated with literate population, agricultural workers, soil nutrients, tractors, advance thresher machines, advance sowing machines, canal length and electrified villages while remaining variables is negatively correlated with pump-sets. Canal irrigation $\left(\mathrm{X}_{18}\right)$ plays a significant role in irrigated area and to increase productivity rather than tube-well irrigation. It is positive correlated with productivity (0.642), and pump-sets (0.578). The partial correlation of canal is positively related with net irrigated area, cropping intensity, soil quality and electrified villages. The variable gross irrigated by tube-well ( $\mathrm{X}_{19}$ ) is highly positively correlated with net irrigated area to gross irrigated area and is highly negatively correlated with canal length. The correlation coefficient value between tubewell and net irrigated area is 0.726 and its correlation coefficient value with canal length is -0.735 .

The variable number of primary agricultural cooperative societies $\left(\mathrm{X}_{20}\right)$ has no significant positive correlation with other variables of agricultural development. It is partially positively correlated with literacy, area under grain, fertilizers consumption and cropping intensity. The variable percentage of electrified villages to total villages $\left(\mathrm{X}_{21}\right)$ is positively correlated with pump-sets and tube-wells and it is highly negatively correlated with advance harrow and cultivators (-0.795). The last variable length of total pakki roads $\left(\mathrm{X}_{22}\right)$ is significant positive correlated with cropping intensity (0.628). The highest negative correlation is shown with two variables i.e. tractors ( -0.686 ) and advance sowing machines (-0.636).

## Inter-relationship among variables (2011-12)

The relationship between variables is seen from the table 6.3 for the year 2011-12. The dependent variable crop productivity ( $\mathrm{X}_{1}$ ) is significantly positively correlated with tractors (0.798), literate population (0.660), net irrigated area (0.656), canal length
(0.653), advance harrow and cultivators (0.645), advance thrasher machines (0.612), sprayers ( 0.583 ) and tube wells ( 0.568 ). Crop productivity was highly dependent on soil quality in 1996-97 but in 2011-12, other variables also play a major role in productivity. The highest negative correlation of productivity is shown with wooden and iron plough (0.803 and -0.724 respectively). The partial positive correlation of productivity is associated with area under grains, net irrigated area to net sown area, cropping intensity, soil quality and length of pakki roads. Remaining variables have partial negative correlation with productivity.

The variable percentage of literate population to total population ( $\mathrm{X}_{2}$ ) is strongly positively correlated with tractors (0.777), sprayers (0.736), advance harrow and cultivators (0.660), net irrigated area to gross irrigated area (0.614) and cooperative societies (0.568) and the highest negative correlation of literate population is shown with wooden plough ( -0.950 ) and iron plough ( -0.954 ). It is observed that literacy plays a dominant role in adopting advance agricultural technology. It is observed that the variable agricultural workers $\left(\mathrm{X}_{3}\right)$ show neither strong positive nor strong negative correlation with other variables. The variable percentage area under food grains to gross cropped area $\left(\mathrm{X}_{4}\right)$ is shown partial positive correlation with wooden plough, iron plough and length of total pakki roads.

The consumption of fertilizers to gross cropped area ( $\mathrm{X}_{5}$ ) is significantly positively correlated with tube-well (0.724), length of pakki roads (0.623) and canal (0.608). It is also positive correlated with agricultural productivity, pump-sets, advance thresher machines and iron plough. It is negatively correlated with cropping intensity and soil nutrients. The variable percentage of net irrigated area to gross irrigated area ( $\mathrm{X}_{6}$ ) indicates that it is highly positively correlated with tube-wells ( 0.816 ), followed by canal length (0.765), pump-set (0.677), agricultural productivity (0.656) and literate population ( 0.614 ) and net irrigated to net sown area (0.556). Its negative strong relationship is associated with wooden plough ( -0.711 ) and iron plough ( -0.696 ). The variable percentage of net irrigated area to net sown area ( $\mathrm{X}_{7}$ ) is positively correlated with variables productivity, agricultural workers, consumption of fertilizers, cropping intensity, tractors, advance agricultural instruments, sources of irrigation, electrified

Table: 6.3
Correlation Matrix of Twenty-Two Variables of Agricultural Development (2011-12)

| Variables | $\mathrm{X}_{1}$ | $\mathrm{X}_{2}$ | $\mathrm{X}_{3}$ | $\mathrm{X}_{4}$ | $\mathrm{X}_{5}$ | $\mathrm{X}_{6}$ | $\mathrm{X}_{7}$ | $\mathrm{X}_{8}$ | X9 | $\mathrm{X}_{10}$ | $\mathrm{X}_{11}$ | $\mathrm{X}_{12}$ | $\mathrm{X}_{13}$ | $\mathrm{X}_{14}$ | $\mathrm{X}_{15}$ | $\mathrm{X}_{16}$ | $\mathrm{X}_{17}$ | $\mathrm{X}_{18}$ | $\mathrm{X}_{19}$ | $\mathrm{X}_{20}$ |  | $\mathrm{X}_{2}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{X}_{1}$ | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{2}$ | 0.660* | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{3}$ | -0.502 | -0.386 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{4}$ | -0.363 | -0.296 | -0.024 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{5}$ | 0.205 | -0.264 | -0.380 | 0.083 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{6}$ | 0.656* | 0.614* | -0.028 | 0.104 | -0.201 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{7}$ | 0.336 | -0.027 | 0.094 | -0.204 | 0.157 | 0.565* | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{8}$ | 0.121 | -0.094 | 0.397 | 0.030 | -0.011 | 0.477 | 0.331 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{9}$ | 0.190 | 0.506 | -0.314 | -0.507 | $-0.087$ | 0.022 | -0.100 | -0.322 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{10}$ | 0.798** | 0.777** | 0.19 | -0.410 | 0.509 | 0.363 | 0.158 | 0.160 | 0.326 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{11}$ | 0.645* | 0.646* | 0.049 | -0.006 | 0.467 | -0.221 | 0.126 | -0.090 | 0.090 | 0.676* | 1 |  |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{12}$ | 0.612* | 0.561* | 0.193 | -0.248 | 0.303 | -0.253 | 0.126 | -0.013 | -0.081 | 0.516 | -0.432 | 1 |  |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{13}$ | 0.583* | 0.736** | -0.569 | -0.624* | -0.108 | 0.175 | 0.024 | -0.285 | 0.687** | 0.355 | 0.027 | $-0.068$ | 1 |  |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{14}$ | 0.370 | 0.407 | -0.165 | -0.223 | $-0.200$ | 0.533 | -0.002 | 0.304 | 0.287 | 0.523 | 0.272 | -0.489 | 0.533 | 1 |  |  |  |  |  |  |  |  |
| $\mathrm{X}_{15}$ | -0.803** | -0.950** | 0.361 | 0.336 | 0.081 | -0.711** | -0.145 | -0.040 | -0.476 | 0.566* | 0.451 | -0.018 | -0.703* | -0.430 | 1 |  |  |  |  |  |  |  |
| $\mathrm{X}_{16}$ | -0.724** | -0.954** | 0.294 | 0.348 | 0.176 | -0.696* | -0.148 | -0.102 | -0.452 | 0.535 | 0.396 | -0.102 | -0.703* | -0.448 | 0.969** | 1 |  |  |  |  |  |  |
| $\mathrm{X}_{17}$ | 0.467 | -0.050 | 0.367 | -0.106 | 0.536 | 0.677* | 0.498 | 0.043 | -0.016 | -0.507 | -0.499 | 0.469 | -0.140 | -0.213 | 0.022 | -0.047 | 1 |  |  |  |  |  |
| $\mathrm{X}_{18}$ | 0.653* | -0.530 | 0.409 | 0.105 | 0.608* | 0.765** | 0.884 | 0.239 | $-0.233$ | -0.385 | -0.150 | 0.162 | -0.557 | -0.384 | 0.410 | 0.462 | 0.595* | 1 |  |  |  |  |
| $\mathrm{X}_{19}$ | 0.568* | -0.251 | -0.049 | -0.391 | 0.724* | 0.816** | 0.507 | -0.119 | $-0.237$ | 0.099 | 0.075 | 0.288 | 0.031 | -0.417 | 0280 | 0.275 | -0.315 | -0.537 | 1 |  |  |  |
| $\mathrm{X}_{20}$ | 0.311 | 0.568* | 0.183 | 0.149 | 0.456 | 0.257 | 0216 | -0.299 | -0.505 | -0.190 | 0.485 | 0.095 | 0.115 | -0.455 | -0.029 | 0.461 | 0.373 | -0.348 | 0.436 | 1 |  |  |
| $\mathrm{X}_{21}$ | 0.474 | 0.315 | -0.527 | 0.027 | 0.271 | 0.361 | 0.034 | -0.178 | 0.03 | -0.113 | -0.233 | -0.312 | 0.118 | 0.051 | -0.361 | -0.215 | -0.358 | -0.036 | 0.423 | -0.067 | 1 |  |
| $\mathrm{X}_{22}$ | 0.359 | -0.091 | -0.451 | 0.364 | 0.623* | 0.118 | 0.168 | 0.187 | -0.567 | -0.566 | -0.397 | -0.095 | -0.251 | -0.288 | 0.008 | 0.078 | -0.001 | 0.178 | 0.054 | 0.332 | 0.488 | 1 |

Source: Computed by Researcher
villages and length of pakki roads while rest set of variables shows negative correlation with net irrigated area to net sown area.

The variable cropping intensity ( $\mathrm{X}_{8}$ ) is positively correlated with productivity, agricultural workers, area under food grains, net irrigated area to gross irrigated area, net irrigated area to net sown area, tractors, advance harrow and cultivators, advance sowing machines, pump-sets, canal length and pakki roads and it is negatively correlated with other variables. It is observed that the variable soil nutrients ( $\mathrm{X}_{9}$ ) is strong positively correlated with sprayers (0.687) followed by advance sowing machines (0.587). It is negatively correlated with length of pakki roads and area under grains ( -0.567 and -0.507 respectively).

When the variable number of tractors $\left(\mathrm{X}_{10}\right)$ is correlated with other variables, it is significantly correlated with productivity (0.798), literate population (0.777), advance harrow and cultivators (0.676) and is negatively correlated with length of pakki roads and ploughs. The advance harrow and cultivators $\left(\mathrm{X}_{11}\right)$ is positively related with literates (0.666) whereas it is negatively correlated with net irrigated area, pump-sets, advance thresher machines, length of pakki roads. The variable number of advance thresher machines ( $\mathrm{X}_{12}$ ) is positive correlated with literacy, fertilizers, tractors, pump-sets, and length of pakki roads and has negative correlation with other variables. The variable sprayers ( $\mathrm{X}_{13}$ ) is significantly positively correlated with literate population (0.736), soil nutrients ( 0.687 ) and productivity ( 0.583 ) and it is highly negatively correlated with wooden and iron plough (-0.703), area under food grains ( -0.624 ), agricultural workers (0.569 ) and length of canals ( -0.557 ). The variable advance sowing machines ( $\mathrm{X}_{14}$ ) is positively correlated with productivity, literacy, tractors, sprayers and net irrigated area to gross irrigated area.

It is clear from the table 6.3 that the wooden and iron ploughs ( $\mathrm{X}_{15}$ and $\mathrm{X}_{16}$ ) have highest negative correlation with productivity, net irrigated area to gross irrigated area, literate population and sprayers. The highly significant positive correlation is shown between iron plough and wooden plough. The correlation values between ploughs are 0.969 .

The correlation of variable number of pump-sets ( $\mathrm{X}_{17}$ ) shows that it is significantly positively correlated with net irrigated area to gross irrigated area (0.677) and canal length (0.595). Its partial positive correlation is associated with agricultural workers, consumption of fertilizers, net irrigated area to net sown area, advance harrow and cultivators, sprayers, advance sowing machines and net irrigated area by tube-wells whereas it is negatively correlated with other variables. Canal length ( $\mathrm{X}_{18}$ ) is significantly positively correlated with net irrigated area to gross irrigated area (0.765), productivity ( 0.653 ) consumption of fertilizers ( 0.608 ). It is partial positively correlated with agricultural workers, cropping intensity and ploughs. It is negatively correlated with sprayers, tube-wells, tractors and electricity. The correlation of tube-well irrigation indicates that it is significantly positively correlated with net irrigated area to gross irrigated area (0.816), net irrigated area to net sown area (0.724), and productivity (0.568). It is also positively correlated with advance thresher machines, ploughs and length of pakki roads. Remaining variables have negative correlation with tube-well irrigation.

The variable primary agricultural cooperative societies $\left(\mathrm{X}_{20}\right)$ is positively related with agriculture workers, fertilizers consumption, pump-sets and ploughs. The partial positive correlation of electrified villages $\left(\mathrm{X}_{21}\right)$ is associated with net irrigated area to gross irrigated area, literate population and pakki roads. It has negative correlation with working population. When the last variable length of pakki roads $\left(\mathrm{X}_{22}\right)$ is correlated with other variables, it is observed that it is highly correlated with fertilizers consumption (0.623). The negative correlation of pakki roads is assigned with soil nutrients ( -0.567 ) and number of tractors $(-0.566)$.

## Factor analysis

Factor analysis is a technique used when the researcher is interested in assessing a small number of factors underlying a large number of observed variables. The subsets of variables are combined into factors that have high correlation between the variables. In the present study, the significant factors with their variables have been identified through factor analysis. The regression coefficients of original values are termed as factor loading
which helps in identifying variables with the particular factors. The factor loading is further assessed by factor rotation which helps in arriving at a simple pattern of factor loading by maximizing high correlation and minimum low ones. Factor rotation is easy to interpret and presents a clear picture of the factor structure of the data sat.

There are numerous authors like Harman (1967), Morrison (1967), Kaiser (1958), Ahmad (1965), Munir (1992), Siddiqui (2005); etc. who used this technique in their studies. In the present work, the factor analysis has been used with the help of SPSS software for the year of 1996-97 and 2011-12. Twenty-two variables have been selected for analyzing agricultural development in Aligarh district. These variables have been rotated for extracting factors. After applying factor rotation method in SPSS, those factors have been considered which have Eigen value more than 2.00.

## Factor analysis (1996-97)

Table 6.4 shows that 79.47 percent of total variance is explained by four factors. The total variance means sum of square loadings. The first factor explains 29.98 percent of the total variance. It is highly strongly loaded on percentage of area under food grains (0.554), cropping intensity (0.935), wooden ploughs (0.755), iron ploughs (0.804), electrified villages ( 0.842 ) and length of total pakki roads ( 0.771 ). In this factor 1 , the cropping intensity is higher because of using ploughs. Pakki roads also play an important role in agricultural development because it provides convinces for farmers and connects villages to cities. This factor has negative loading with literacy, tractors, pump sets, sprayers, advance sowing machines and tube well irrigation. It means that the farmers used plough because of illiteracy. Ploughs were essential means of growing grains. The name of this factor may be given as "Cropping Intensity, Traditional plough and Infrastructures".

The second factor accounts for 19.77 percent of the total variance. It has positive loading (more than 0.80 ) with two variables. They are agricultural productivity ( 0.800 ) and soil quality (0.831). It has negative loading on advance harrow and cultivators and thresher machines (loading more than 0.650). This second factor indicates that agricultural productivity is affected by soil quality. It proves that soil quality is good,

Table 6.4
Factor Loading of Variables (1996-97)

|  | F1 | F2 | F3 | F4 |
| :---: | :---: | :---: | :---: | :---: |
| Variables | Cropping Intensity, Traditional Plough \& Infrastructure | Productivity\& Soil Quality | Literacy \& Mechanization | Irrigation Facilities |
| $\mathrm{X}_{1}$ | 0.065 | 0.800 | -0.008 | 0.058 |
| $\mathrm{X}_{2}$ | -0.584 | 0.484 | 0.530 | -0.004 |
| $\mathrm{X}_{3}$ | -0.144 | -0.242 | -0.752 | -0.035 |
| $\mathrm{X}_{4}$ | 0.554 | -0.261 | -0.664 | -0.053 |
| $\mathrm{X}_{5}$ | 0.058 | -0.137 | 0.481 | 0.012 |
| $\mathrm{X}_{6}$ | 0.426 | 0.393 | 0.070 | 0.736 |
| $\mathrm{X}_{7}$ | -0.454 | 0.428 | 0.307 | 0.527 |
| $\mathrm{X}_{8}$ | 0.935 | 0.090 | -0.022 | 0.239 |
| $\mathrm{X}_{9}$ | -0.175 | 0.831 | 0.047 | 0.082 |
| $\mathrm{X}_{10}$ | -0.861 | 0.337 | 0.643 | 0.020 |
| $\mathrm{X}_{11}$ | 0.311 | -0.653 | 0.441 | -0.291 |
| $\mathrm{X}_{12}$ | -0.093 | -0.756 | 0.262 | 0.105 |
| $\mathrm{X}_{13}$ | -0.435 | -0.182 | 0.760 | -0.263 |
| $\mathrm{X}_{14}$ | -0.802 | 0.040 | 0.263 | -0.071 |
| $\mathrm{X}_{15}$ | 0.755 | -0.309 | -0.432 | -0.001 |
| $\mathrm{X}_{16}$ | 0.804 | -0.119 | -0.562 | -0.241 |
| $\mathrm{X}_{17}$ | -0.570 | -0.217 | -0.071 | 0.743 |
| $\mathrm{X}_{18}$ | 0.031 | 0.150 | -0.072 | 0.924 |
| $\mathrm{X}_{19}$ | -0.333 | -0.151 | -0.057 | 0.351 |
| $\mathrm{X}_{20}$ | 0.435 | -0.036 | -0.025 | 0.161 |
| $\mathrm{X}_{21}$ | 0.842 | -0.241 | 0.161 | 0.230 |
| $\mathrm{X}_{22}$ | 0.771 | -0.082 | 0.334 | -0.006 |
| \% of Variance | 29.98 | 19.77 | 15.79 | 13.91 |
| Cumulative \% Variance | 29.98 | 49.76 | 65.56 | 79.47 |
| Initial Eigen Values | 7.447 | 4.166 | 2.383 | 2.064 |

Sources: Computed by Researcher
productivity is also high. The advance tools of agriculture shows negative impacts on soil nutrients that affects crop productivity. It may be named as "Productivity and Soil quality".

The third factor explains 15.79 percent of the total variance. The variance in third factor are having positive loading with literacy (0.530), number of tractors (0.643), consumption of fertilizers (0.481), number of advance harrows and cultivators (0.441) and it has negative loading on agriculture workers (-0.752), area under food grains (0.664 ) and iron ploughs ( -0.562 ). The third factor may be named as "Literacy and Mechanization".

The fourth factor describes 13.91 percent of the total variance. It is strongly loaded on percentage of net irrigated area to gross irrigated area (0.736), percentage of net irrigated area to net sown area (0.527), number of pump-sets (0.743) and canal length (0.924) and tube wells (0.351). "Irrigation facilities" may be good name for this factor.

## Factor scores (1996-97)

Factor scores are used for graphical presentation of spatial variation of factors. The standardized factor scores have been calculated on regression by SPSS. It has been divide into three grades of high, medium and low. The high factor scores have value more than 0.50 and the low factor scores have value less than -0.50 . The medium score fall between the values -0.50 to 0.50 in all factors.

It is seen from the figure 6.1, the area of high factor scores of factor 1 are concentrated in the eastern part of the study region. They constitute a contiguous region extending over Akrabad, Atrouli and Bijouli blocks. Another block of same grade is Dhanipur which lie in the middle part of the region. The medium scores of factor 1 include Jawan, Lodha and Gangiri blocks. The areas having low grade factor scores extend over western part of the region. It includes Tappal, Khair, Chandaus, Gonda and Iglas.

Figure 6.2 indicates that high factor scores 2 constitute northern part of the region including Tappal, Khair, Jawan and Atrouli. Another block i.e. Dhanipur also records

Table 6.5
Factor Scores of Variables (1996-97)

|  | Factor Scores 1 | Factor Scores 2 | Factor Scores 3 | Factor Scores 4 |
| :---: | :---: | :---: | :---: | :---: |
| Blocks | Cropping <br> Intensity, <br> Traditional <br>  <br> Infrastructure | Productivity \& Soil Quality | Literacy \& Mechanization | Irrigation Facilities |
| Tappal | -1.838 | 1.408 | -1.176 | 0.535 |
| Khair | -0.856 | 0.783 | -0.514 | -0.088 |
| Chandaus | -0.523 | 0.046 | 1.011 | -0.913 |
| Jawan | 0.409 | 0.591 | 1.007 | 0.990 |
| Lodha | 0.051 | 0.129 | 1.524 | -1.441 |
| Dhanipur | 1.045 | 0.837 | 0.363 | 0.690 |
| Akrabad | 0.829 | 0.152 | 0.139 | 1.587 |
| Gonda | -1.229 | -1.696 | -0.206 | 0.423 |
| Iglas | -0.594 | -0.945 | 1.074 | 0.012 |
| Atrouli | 1.167 | 0.974 | -1.002 | -1.513 |
| Bijouli | 1.125 | -1.128 | -0.814 | 0.668 |
| Gangiri | 0.416 | -1.150 | -1.407 | -0.951 |

[^7]Table 6.6

## Standard Factor Scores of Agricultural Development in Aligarh District (1996-97)

| Categories | Standard <br> Factor Score <br> Range | Factor Scores 1 |  | Factor Scores 2 |  | Factor Scores 3 |  | Factor Scores 4 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | No. of Blocks | Name of Blocks | No. of Blocks | Name of Blocks | No. of Blocks | Name of Blocks | No. of Blocks | Name of Blocks |
| High | Above 0.50 | 4 | Dhanipur, Akrabad, Atrouli, Bijouli | 5 | Tappal, Khair, Jawan, Dhanipur, Atrouli | 4 | Chandaus, Jawan, Lodha, Iglas | 5 | Tappal, Jawan, Dhanipur, Akrabad, Bijouli |
| Medium | $\begin{gathered} \text { Between } \\ -0.50 \text { to } 0.50 \end{gathered}$ | 3 | Jawan, Lodha, Gangiri | 3 | Chandaus, Lodha, Akrabad | 3 | Dhanipur, Akrabad, Gonda | 3 | Khair, Gonda, Iglas |
| Low | Below -0.50 | 5 | Tappal, Khair, Chandaus, Gonda, Iglas | 4 | Gonda, Iglas, Bijouli, Gangiri | 5 | Tappal, Khair, Atrouli, Bijouli, Gangiri | 4 | Chandaus, Lodha, Atrouli, Gangiri |

Source: Computed by Researcher based on table 6.5
high factor score which lie in the middle part of the region. The medium grade factor scores 2 include Chandaus, Lodha and Akrabad and they are closest to the areas of high factor scores. The low scores of this factor have been seen in four blocks i.e. Bijouli, Gangiri, Gonda and Iglas.

The spatial variation based on factor scores 3 is depicted in figure 6.3. This figure shows that high grade factor scores extend over four blocks namely Chandaus, Jawan, Lodha and Iglas. The medium scores concentrate in three blocks which are Dhanipur, Akrabad and Gonda. There are five blocks that fall in the category of low grade factor scores forming the eastern and western part of the region. They include Tappal, Khair, Atrouli, Bijouli and Gangiri.

The spatial pattern of factor scores 4 is shown in figure 6.4. The areas of high factor scores are not scattered over contiguous belt while it is spread in all parts of the region. They include the blocks of Tappal, Jawan, Dhanipur, Akrabad and Bijouli. Irrigation facilities are high in Jawan, Dhanipur and Akrabad due to upper ganga canal irrigation and high in Bijouli due to lower ganga canal. Only three blocks have medium factor scores 4. They form a contiguous belt of the southern region; comprising Khair, Gonda and Iglas whereas the low grade of factor score 4 cover 4 blocks namely, Chandaus, Lodha, Atrouli and Gangiri.

## Factor Analysis (2011-12)

The rotated factor matrix is calculated in SPSS for the year 2011-12 of twentytwo variables of agricultural development. Table 6.7 indicates that four factors extracted from twenty-two variables. These four factors explain 74.38 percent of the total variance.

Factor 1 accounts only 30.43 percent of total variance is heavily loaded on six variables which have loading more than 0.500 . They are Agricultural Productivity (0.729), Percentage of literate persons to total population (0.906), advance thresher machines (0.783), Sprayers (0.908), Soil nutrients (0.702), advance sowing machines (0.510). It has also positive loading with tractors (0.446) and advance harrow and cultivators (0.342).


Figure 6.1

## ALIGARH DISTRICT

Factor Score 2 of Agricultural Developmnet, 1996-97


Figure 6.2


Figure 6.3


Figure 6.4

It is strongly negative loaded on wooden ( -0.916 ) and iron $(-0.907)$ ploughs. It clearly indicates that productivity is highly depended on soil conditions in both the study periods. It is observed that literacy is directly related with adopting advance agriculture technology. Therefore, the name for factor 1 is suitable as "Productivity, Literacy and Mechanization".

Factor 2 explains 15.62 percent of total variance. It is strongly positively loaded with fertilizers, area under food grains, electricity and pakki roads. So this factor may be called as "Fertilizers and Infrastructure". The variance fertilizer is loaded with loading 0.593 . This factor has also strong loading on electrified villages (0.902) and pakki roads (0.731).

The third factor accounts 15.01 percent of the total variance. It has strongly loaded on four variables having more than 0.50 percent. They are fertilizers consumption (0.508), number of pump-sets (0.844) and Canal lengths (0.508). It is also positively loaded with net irrigated area and tube-wells. The fifth variable fertilizer consumption accounts 0.593 in second factor whereas it accounts 0.508 loading in third factor. It shows high loading in second factor so it is eliminated from the third factor and variables of irrigated area is high loaded in factor 4 therefore it also eliminated from this factor. "Irrigation facilities" is good name for third factor.

The name for fourth factor may be given as "Cropping intensity and Irrigated area". It is strongly positive loaded on percentage of net irrigated area to gross irrigated area ( 0.761 ), percentage of net irrigated area to net sown area ( 0.551 ) and cropping intensity (0.752). The variable agricultural worker has also positive loading (0.401) which has highest loading in fourth factor out of all factors.

## Factor scores 2011-12

The standardized factor scores have been calculated to easy combination of variables unevenly distributed in the region. The scores of factors are shown in the table 6.8 for the year 2011-12.

Figure 6.5 shows that high grade factor scores 1 comprise is scattered over blocks

Table 6.7
Factor Loading of Variables (2011-12)

| Variables | F1 | F2 | F3 | F4 |
| :---: | :---: | :---: | :---: | :---: |
|  | Productivity, Literacy \& Mechanization | Fertilizers\& Infrastructure | Irrigation Facilities |  |
| $\mathrm{X}_{1}$ | 0.729 | 0.451 | -0.092 | 0.265 |
| $\mathrm{X}_{2}$ | 0.906 | 0.126 | -0.051 | 0.149 |
| $\mathrm{X}_{3}$ | -0.444 | -0.656 | 0.211 | 0.401 |
| $\mathrm{X}_{4}$ | -0.571 | 0.402 | -0.225 | 0.19 |
| $\mathrm{X}_{5}$ | -0.107 | 0.593 | 0.508 | -0.066 |
| $\mathrm{X}_{6}$ | 0.464 | 0.204 | 0.302 | 0.761 |
| $\mathrm{X}_{7}$ | 0.038 | -0.014 | 0.404 | 0.551 |
| $\mathrm{X}_{8}$ | -0.147 | -0.081 | 0.017 | 0.752 |
| $\mathrm{X}_{9}$ | 0.702 | -0.327 | -0.055 | -0.216 |
| $\mathrm{X}_{10}$ | 0.446 | -0.53 | -0.539 | 0.16 |
| $\mathrm{X}_{11}$ | 0.342 | -0.443 | -0.666 | -0.166 |
| $\mathrm{X}_{12}$ | 0.783 | -0.158 | 0.052 | -0.139 |
| $\mathrm{X}_{13}$ | 0.908 | -0.087 | -0.11 | -0.247 |
| $\mathrm{X}_{14}$ | 0.515 | -0.206 | -0.498 | 0.336 |
| $\mathrm{X}_{15}$ | -0.916 | -0.181 | -0.026 | -0.293 |
| $\mathrm{X}_{16}$ | -0.907 | -0.069 | -0.059 | -0.311 |
| $\mathrm{X}_{17}$ | -0.052 | -0.149 | 0.844 | 0.215 |
| $\mathrm{X}_{18}$ | -0.537 | 0.006 | 0.508 | 0.327 |
| $\mathrm{X}_{19}$ | -0.107 | -0.059 | 0.426 | -0.238 |
| $\mathrm{X}_{20}$ | -0.408 | 0.341 | -0.435 | -0.125 |
| $\mathrm{X}_{21}$ | -0.206 | 0.902 | 0.115 | 0.131 |
| $\mathrm{X}_{22}$ | 0.255 | 0.730 | -0.227 | 0.034 |
| \% of Variance | 30.43 | 15.62 | 15.01 | 13.31 |
| Cumulative \% Variance | 30.43 | 46.06 | 61.07 | 74.38 |
| Initial Eigen Values | 6.378 | 3.633 | 2.970 | 2.562 |

Source: Computed by Researcher

Table 6.8
Factor Scores of Variables (2011-12)

| Blocks | Factor Scores 1 | Factor Scores 2 | Factor Scores 3 | Factor Scores 4 |
| :---: | :---: | :---: | :---: | :---: |
|  | Productivity, Literacy \& Mechanization | Fertilizers \& Infrastructure | Irrigation Facilities |  |
| Tappal | 0.712 | 0.362 | 0.707 | 0.645 |
| Khair | 0.639 | -0.750 | 0.205 | 0.262 |
| Chandaus | 0.215 | 0.020 | -0.689 | -1.215 |
| Jawan | 0.341 | 0.930 | -0.006 | 0.131 |
| Lodha | 0.316 | 1.046 | -0.853 | -1.356 |
| Dhanipur | -0.015 | 0.915 | -0.403 | -0.062 |
| Akrabad | 0.446 | 0.455 | 0.524 | 2.297 |
| Gonda | -0.571 | -1.143 | 1.619 | 0.369 |
| Iglas | 1.191 | 0.065 | 1.317 | 0.310 |
| Atrouli | 0.528 | 1.405 | 0.356 | 0.666 |
| Bijouli | -1.532 | -0.153 | -0.241 | -0.391 |
| Gangiri | -2.331 | -1.056 | -0.455 | -1.038 |

Source: Computed by Researcher

Table 6.9
Standard Factor Scores of Agricultural Development in Aligarh District (2011-12)

| Categories | Standard <br> Factor <br> Score <br> Range | Factor Score 1 |  | Factor Score 2 |  | Factor Score 3 |  | Factor Score 4 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | No. of Blocks | Name of Blocks | No. of Blocks | Name of Blocks | No. of Blocks | Name of Blocks | No. of Blocks | Name of Blocks |
| High | Above 0.50 | 4 | Tappal, Khair, Iglas, Atrouli | 4 | Jawan, Lodha Dhanipur, Atrouli | 4 | Tappal, Akrabad, Gonda, Iglas | 3 | Tappal, Akrabad, Atrouli |
| Medium | $\begin{gathered} \text { Between } \\ -0.50 \text { to } \\ 0.50 \\ \hline \end{gathered}$ | 5 | Chandaus, Lodha, Jawan, Dhanipur, Akrabad | 4 | Chandaus, Akrabad, Iglas, Bijouli | 5 | Khair, Jawan, Dhanipur, Atrouli, Gangiri | 6 | Khair, Jawan, Dhanipur, Gonda, Iglas, Bijouli |
| Low | $\begin{gathered} \text { Below - } \\ 0.50 \end{gathered}$ | 3 | Gonda, Bijouli, Gangiri | 4 | Tappal, Khair, Gonda, Gangiri | 3 | Chandaus, <br> Lodha, Bijouli | 3 | Chandaus, Lodha, Gangiri |

[^8]

Figure 6.5


Figure 6.6


Figure 6.7


Figure 6.8
of Tappal, Khair, and Iglas and Atrouli. The medium factor scores spread over five blocks i.e. Chandaus, Lodha, Jawan, Dhanipur and Akrabad. The low grade factor scores extend over blocks of Bijouli, Gangiri and Gonda.

The spatial variation of factor score 2 depicts in figure 6.6. This figure clearly shows that the high grade factor score are concentrated in the middle part of the region. They include Jawan, Lodha, and Dhanipur and Atrouli. These blocks are close to Aligarh city. The medium factor score cover four blocks i.e. Chandaus, Akrabad, Iglas and Bijouli. The low grade factor scores include Tappal, Khair, Gonda and Gangiri.

As shown in figure 6.7, the high factor scores of factor 3 are concentrated in the Tappal, Akrabad, Gonda, and Iglas whereas the low grade score scores comprise three blocks i.e. Chandaus, Lodha and Bijouli. The medium grade scores are scattered in different parts of the region including five blocks namely, Khair, Jawan, Dhanipur, Atrouli and Gangiri.

The factor scores of factor 4 are depicted in figure 6.8 it shows that there are three blocks namely Tappal, Akrabad and Atrouli fall under the category of high grade scores. The medium factor scores concentrate in the blocks of Khair, Jawan, Dhanipur, Gonda, Iglas and Bijouli whereas the low grade factor score occupy the blocks of Chandaus, Lodha and Gangiri. No grade of factor scores 4 make any part compact and contiguous region.

## Levels of Agricultural Development: Based Composite Z - Score

An attempt has been made to analysis the level of agricultural development with the help of composite index of twenty-two variables in the study region for the two periods i.e. 1996-97 and 2011-12. Each variable has its own different weight. Therefore, the uneven distribution of variables in the study area, the data of all variables have been transformed into indices using z-score technique. The formula is

$$
Z i=\frac{X i-\overline{\mathrm{x}}}{\mathrm{SD}}
$$

Where,
$\mathrm{Z}_{\mathrm{i}}=$ standard score of the ith observation
$\mathrm{Xi}=$ actual value of the ith observation
$\overline{\mathrm{X}}=$ mean of the value of X variable
$\mathrm{SD}=$ standard deviation of X variable
Further the results of the standard score obtained for different indicators, where aggregated by composite standard score (CSS) so that spatial variation in the levels of agricultural development of blocks are obtained on a mean and standard deviation scale. The equation of composite standard score is algebraically expressed as:

$$
\mathrm{CSS}=\frac{\sum z i j}{N}
$$

CSS = Composite Standard Score
$\mathrm{Zij}=\mathrm{Z}$ score of an indicator j in block i
$\mathrm{N}=$ Number of Variables
In order to classify the blocks according to their levels of agricultural development the composite standard score have been divided into three classes that are high, medium and low.

## Levels of Agricultural Development (1996-97)

It is clear from the figure 6.9 that there is wide variation in the level of agricultural development in their spatial units in Aligarh district. In the year 1996-97, high category of agriculture development covers 41.66 percent area of the district. In this category, five blocks have been identified namely, Tappal, Jawan, Dhanipur, Akrabad and Atrouli. In these five blocks, Dhanipur (0.155) recorded highest level of agricultural development followed by Tappal (0.117) and Atrouli (0.097), Jawan (0.094) and Akrabad (0.077). These blocks have been achieved high level of agricultural development due to high productivity, good soil quality, use of advance thresher machines, tractors and canal irrigation.

The medium level of agricultural development covered four blocks of region namely Iglas (0.051), Chandaus (0.044), Bijouli (-0.003) and Gonda (-0.038). These
blocks have been achieved moderate agricultural development due to high percentage area under food grains, use of pump-sets and advance sowing machines.

The low level of agricultural development has been noticed in three blocks, namely, Gangiri ( -0.138 ), Lodha ( -0.204 ) and Khair ( -0.253 ). This low agricultural development is due to low use of plough, low cropping intensity and lack of irrigation facilities.

Table 6.10
Block-wise Levels of Agricultural Development in Aligarh District (1996-97)

| Categories | Index Range | No. of <br> Blocks | Percentage <br> of the total <br> District | Name of Blocks |
| :---: | :---: | :---: | :---: | :---: |
| High | Above 0.085 | 5 | 41.66 | Tappal, Jawan, Dhanipur, <br> Akrabad, Atrouli |
| Medium | Between -0.085 <br> to 0.085 | 4 | 33.33 | Chandaus, Gonda, Iglas, Bijouli |
| Low | Below -0.085 | 3 | 25 | Khair, Lodha, Gangiri |

Source: Computed by Researcher based on Appendix I

## Levels of Agricultural Development (2011-12)

In the year 2011-12, a remarkable change has been noticed in the level of agricultural development. Table 6.11 indicates that four blocks have been achieved good progress in agricultural development. They are Akrabad (0.315), Iglas (0.315), Tappal (0.161) and Atrouli (0.137) while in the year 1996-97, Iglas block recorded medium level of agricultural development. They attained high level of agricultural development in the year 2011-12 due to high cropping intensity, high productivity, high per hectare consumption of fertilizers, high use of advance agriculture technology and good irrigation practices.

The medium level of agricultural development covers 41.66 percent area of the district and extends in the middle part of the region. There are five blocks which fall in


Figure 6.9


Figure 6.10

Table 6.11
Block-wise Levels of Agricultural Development in Aligarh District (2011-12)

| Categories | Index Range | No. of <br> Blocks | Percentage <br> of the total <br> District | Name of Blocks |
| :---: | :---: | :---: | :---: | :---: |
| High | Above 0.085 | 4 | 33.33 | Tappal, Akrabad, Iglas, Atrouli |
| Medium | Between <br> -0.085 to 0.085 | 5 | 41.66 | Khair, Jawan, Lodha, Dhanipur, <br> Gonda |
| Low | Below -0.085 | 3 | 25 | Chandaus, Bijouli, Gangiri |

Source: Computed by Researcher based on Appendix II
this category. They are Dhanipur (0.081), Lodha ( -0.032 ), and Gonda ( -0.066 ), Jawan ( -0.068 ) and Khair ( -0.073 ). These blocks have been achieved moderate agriculture development due to high agricultural productivity, high literates and good infrastructure facilities.

There are three blocks namely, Chandaus, Bijouli and Gangiri which have been reported under the low level of agricultural development with the index value with -$0.277,-0.086$ and -0.293 respectively. An interesting point to note is that Chandaus block has been recorded medium level of agricultural development in the year 1996-97. The irrigation facilities of Chandaus block are very poor. Agricultural technological advancement has been recorded poor in Chandaus and Gangiri block.

Overall analysis of twenty-two variables of agricultural development, it reveals that there is shifting of blocks from high to medium, medium to high and low to medium. During 1996-97, Chandaus and Iglas blocks were under medium level of agricultural development while Chandaus comes under the low level and Iglas falls under high level of agricultural development in the year 2011-12. During 1996-97 to 2011-12, there are two blocks namely, Jawan and Dhanipur which replaced their position from high to medium level. The factors behind this changing are poor irrigation facilities and low cropping intensity. Khair and Lodha blocks transferred their position from low to
medium level of agricultural development. Another thing is that where irrigation facilities are adequate, agricultural development is dynamic and vice versa.

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## CHAPI ${ }^{\prime}$ R-7

## $\mathcal{A}$ MICRO LEVEL

$\mathcal{A} \mathcal{N A L}$ YSIS OF SELECTED
VILLAGES IN $\mathcal{A}$ LIGARH DISTRICT

The field survey is an essential component for collecting and gathering information at the local level or ground level by conducting primary survey through observations, questionnaire, schedule and interviews. The field work has been conducted in 24 villages of Aligarh district on the basis of purposive random sampling. Two villages are selected from each block, one is selected along the road and other is more than 3 km far away from the road. The population size of each village falls approximately between 1500 to 2000 persons (Census of India, 2011) and 10 percent of households from each village are surveyed with the help of a well prepared schedule and general observation of the condition of the farmers.

The researcher visited villages herself to collect the information about age, education status of farmers, size of land holdings, affects of various factors on cropping pattern, use of agricultural implements, and sources of irrigation. The survey work has been carried out in Rabi season during January 2016 to March 2016. The researcher has also collected the information about Kharif crops of 2015.

### 7.1 Demographic Profile of Selected Villages

The demographic characteristic of selected villages is shown in table 7.1. The total area covered by all selected villages is 6717.86 hectares.

1) Takipur - Takipur village is located along the Palwal-Aligarh road in Tappal block which is 7 kilometers far away from Jattari town and 35 kilometers from Aligarh district headquarter. It lies on $27^{\circ} 59^{\prime} \mathrm{N}$ latitude and $77^{\circ} 43^{\prime} \mathrm{E}$ longitudes. This village covers 206.6 hectares area with 355 household. The total population of Takipur is 2,038 persons, out of which 53.68 percent are males and 46.32 percent are females. (Census 2011). The total literates are 1,208 persons. The primary, upper primary school and one public school are located in Takipur.
2) Hetalpur- It is located in western part of Tappal Block, away 5 kilometers from Jattari and 4.5 kilometers away from Palwal-Aligarh road. Its areal extent is on $28^{\circ} 00^{\prime} \mathrm{N}$ latitudes and $77^{\circ} 37^{\prime}$ E longitudes. Hetalpur village covering a total area of 254.4 hectares with a population of 2,121 persons (2011). Out of total population, 52.29 percent are

Table 7.1
List of Selected Villages in Aligarh District, 2016

| Blocks | S.No. | Villages | Total Area | Population <br> Total <br> Households |  | No. of <br> Surveyed <br> Households | Literates |
| :---: | :---: | :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: |

Source: Based on data obtained from Village and Town Wise Primary Census Handbook, Aligarh District (2011) and field survey (2016)


Figure 7.1
males and 47.71 percent are females. It comprised 1309 literates and 355 total households, out of which 37 households are surveyed. Both primary and upper primary schools are found in this village.
3) Elampura- The village of Elampura is situated along Deorau road in Chandaus Block. It has a distance of 3 kilometers from Chandaus headquarter and 38 kilometers from district head quarter. It lies on $28^{\circ} 05^{\prime} \mathrm{N}$ latitude and $77^{\circ} 49^{\prime} \mathrm{E}$ longitudes. It has an area of 308.7 hectares and a population is 2,003 persons (2011). Out of whom, 52.92 percent are males and 47.08 percent are females to total population of this village. This village comprised 346 households and 1,278 literates ( 63.80 percent to total population of the village) according to Census 2011. Indian public school and one primary school are found in Elampura village. Gandhi Inter College is 3 kilometers away from Elampura located in Chandaus.
4) Markhi- It is situated at a distance of 4 kilometers from Somna-Khair road. It is located at $28^{\circ} 2^{\prime}$ Latitudes and $77^{\circ} 54^{\prime}$ longitudes in Chandaus block and is situated at a distance of 12 kilometers from block headquarter and 30 kilometers from district headquarter. This village has an area of 223.56 hectares with a total population of 1,544 persons, comprise 53.88 percent males and 46.12 percent females. According to Census 2011, there are 235 households in this village. There is one primary school and one private school in this village. There are two inter colleges i.e. Shri Kalyan Singh Inter College and Shrimati Sheela Gautam Girls Inter College in Veerpura that is 3 kilometers away from Markhi village and one degree college (Kehrimal Gautam Memorial Degree College) is located in Nagla Sarua that 1.5 kilometers away from this village.
5) Ainchana- It is situated along Somna-Khair road at a distance of 4 kilometers from the Khair tehsil headquarter and lies at $27^{\circ} 58^{\prime} \mathrm{N}$ latitudes and $77^{\circ} 52^{\prime} \mathrm{E}$ longitudes in Khair block. This village has the highest population of 2,362 persons in comparison to other sampled villages. Out of the total population, males constitute 53.34 percent and 46.66 percent are female population (Census 2011). There are 372 households in this village covering an area of 295.3 hectares. The total literates in the village are 1,606 , which is the highest among all the sampled villages. The primary and middle school are available in this village and a college is also available at a distance of 4 kilometers from the village. This village has many rich persons so it is most developed village.
6) Kasison- It is also located in Khair block and lies on $27^{\circ} 55^{\prime} \mathrm{N}$ latitudes and $77^{\circ} 48^{\prime} \mathrm{E}$ longitudes. It is situated at a distance 4 kilometers from Khair tehsil headquarter. This village covers an area of 503.8 hectares, which is the second largest after Ektajpur in all selected villages. This village comprises 2,032 persons, out of which 53.59 percent are males and 46.41 percent are females with 1,352 literates. There is one primary and one higher secondary school in this village.
7) Tejpur- Tejpur is situated along Anupsahar road at a distance from 2 kilometers from Jawan headquarter. It is located on $28^{\circ} 03^{\prime} \mathrm{N}$ latitude and $78^{\circ} 07^{\prime} \mathrm{E}$ longitudes. According to Census 2011 there are 1, 958 persons ( 51.99 percent males and 48.01 percent females). There are 298 households in the village covering an area of 330.1 hectares. One primary school is available in this village.
8) Faridpur - It is also located in Jawan block 3 kilometers away from Anupsahar road and 4 kilometers away from Jawan headquarter. It lies on $28^{\circ} 01^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 04^{\prime} \mathrm{E}$ longitudes. The village has 308.6 hectares, and the population consist 1,886 persons which accounts 319 households according to Census 2011. There are 54.67 percent males and 45.33 percent females. The total literates of Faridpur are 1248, accounting 66.17 percent to total population. One primary school is located in village.
9) Luosara Bisawan - This village is situated on Grand Trunk Road, nearly 7 kilometers from Aligarh city. It is located in Lodha block at $27^{\circ} 53^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 00^{\prime} \mathrm{E}$ longitudes. According to Census 2011, the total area of the village is 355.6 hectares (second largest next to Kasison) with total pupation of 1,778 persons, 1,199 literates and 289 households. The male population constitutes 52.98 percent and 47.02 are females.
10) Kaithwari - This village also forms a part of Lodha block and is situated at a distance of 13 kilometers from Aligarh district headquarter. It is located on $27^{\circ} 50^{\prime} \mathrm{N}$ latitudes and $77^{\circ} 59^{\prime}$ E longitudes. This village covers an area of 204.1 kilometers with 278 households. This village has 1,527 persons, out of which 53.17 percent belong to males and rest of females. The total literates of this village are 1, 032 persons (Census 2011).
11) Boner- It is located at $27^{\circ} 51^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 08^{\prime} \mathrm{E}$ longitudes in Dhanipur Block and is 8 kilometers away from Aligarh city. It is along Aligarh-Kanpur road and occupies total area of about 171.2 hectares. According to 2011 Census, its total population is 1,611
with 51.46 percent males and 48.54 percent females. This village has 1,002 literates. There is only one primary school in this village.
12) Pikhlauni- It lies at $27^{\circ} 52^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 08^{\prime} \mathrm{E}$ longitudes in Dhanipur block, away from road. The total population of Pikhlauni is 2,142 in which the males and females contribute 54.48 percent and 45.52 percent respectively. The literates of this village are 1,396 and the size of households is 321 (Census 2011). There is one secondary school in Pikhlauni.
13) Bistauli- It is situated on $27^{\circ} 42^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 15^{\prime} \mathrm{E}$ longitudes along a road covering an area of 422.7 hectares in Akrabad block. It is 12 kilometers away from Akrabad block headquarter and 32 kilometers from district headquarter. Vijaygarh is nearest town to Bistauli which is approximately 4 kilometers away. It contains 1,969 persons, out of which it constitutes 54.70 percent males and rest females. It comprises 377 households according to 2011 Census.
14) Khurrampur - It is also located in Akrabad block at $27^{\circ} 47^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 12^{\prime} \mathrm{E}$ longitudes. It is 6 kilometers distances from block headquarter and about 20 kilometers from district headquarter. From the table 7.1, it appears that the total area of Khurrampur is 239.68 hectares. The population of this block is about 1,990 persons. The male and female population is 53.27 percent and 46.73 respectively. About 62.50 percent population is literates and the total households are 341 (Census 2011). There is one primary school and one Shri Govind Ram Higher School that are found in Khurrampur village.
15) Pilkhuni - It is situated along Atrouli-Ramghat road at a distance of 2 kilometers from the Atrouli tehsil and block headquarter and about 26 kilometers from Aligarh city. It is located on $28^{\circ} 03^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 17^{\prime}$ E longitudes. The total population of the Pilkhuni is 1544 out of which the male population is 51.62 percent and the female population is 48.38 percent. The total households are 266 and total literates are 861 . There are one primary and one upper primary school in this village whereas there are many convent schools, inter colleges and degree colleges that are found in Atrouli town which is approximately only 2 kilometers away from this village.
16) Govali - It is also located in Atrouli block at $28^{\circ} 00^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 12^{\prime} \mathrm{E}$ longitudes at a distance from about 4 kilometers from Atrouli-Ramghat road. The total population of
this village accounts 1,956 persons ( 52.97 percent males and 47.03 percent females). With a total area of 359.34 hectares, this village comprises 292 total households (Census 2011). According to Census 2011, the total literates are 1,335 constituting 68.25 percent to the total population of this village. One primary school and one sunrise public school is established in Govali village.
17) Taraichi- This village lies at $27^{\circ} 59^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 22^{\prime} \mathrm{E}$ longitudes in the block of Bijouli. It is 12 kilometers at a distance from Chharra Rafatpur town and about 36 kilometers from Aligarh city. The village with a population of 1,753 persons occupies an area of 205.5 hectares. The total households are 327 according to Census 2011. As per 2011 Census, male population constitutes 52.94 percent to the total population and rest of females are 47.06 percent. There is no school in Taraichi village.
18) Alipur- The village Alipur is situated in Bijouli block at a distance about 40 kilometers from district headquarter. It lies on $28^{\circ} 04^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 26 \mathrm{E}$ longitudes, covering an area of 203.25 hectares. The total population, as per 2011 census, is 1,969 persons. Out of the total population, 54.19 percent are males while 45.81 percent are females. The total literates in this village are 933 while the village has 329 households. There is no school in Alipur village.
19) Makhdum Nagar - It is located on $27^{\circ} 51^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 27^{\mathrm{E}}$ E longitudes in Gangiri block. It has a distance about 1 kilometer from Gangiri town and 45 km from district headquarter. According to Census 2011, it has 1701 persons ( 876 males and 825 females) and has an area about 182.7 hectares. The total literates are 51.91 percent. This village has 279 total households. It is less developed village in all villages. No school is found in Makhdum Nagar.
20) Rahmapur - It lies on $27^{\circ} 55^{\prime} \mathrm{N}$ latitudes and $78^{\circ} 76 \mathrm{E}$ longitudes. It covers about 490 hectares area and comprises about 1,775 persons. Out of total population, this village constitutes 54.31 percent males and 45.69 percent females. It is approximately 14 kilometers from Atrouli town and about 30 kilometers from Aligarh city. This village has 1, 085 literates ( 61.13 percent to total population) as per 2011 census. It comprises 310 households. Primary school is found in this village.
21) Ektajpur - It is situated along Khair-Gonda Road at a distance 3 kilometers from Gonda block headquarter. It is located at $27^{\circ} 50^{\prime} \mathrm{N}$ latitudes and $77^{\circ} 52^{\prime} \mathrm{E}$ longitudes. This village
covers an area of 568 hectares which is highest in all selected villages. It comprises 1,924 persons, out of whom 54.20 percent persons belong to males and remaining 45.80 percent are females. The village of Ektajpur has 330 households, out of which 33 has been surveyed. The literates of this village are 1,210 (Census 2011). There is one primary school and one secondary school in this village.
22) Gidaura- It is interior village in Gonda block. It is located at $27^{\circ} 44^{\prime} \mathrm{N}$ latitudes and $77^{\circ} 51^{\prime}$ E longitudes. This village has 1,889 persons covering an area of 191 hectares. The total households of this village are 351 according to 2011 Census. It has 58.50 percent literates to total population of this village. There is one primary school in this village.
23) Taharpur - It is situated along the Aligarh-Iglas road at a distance of 15 kilometers from Aligarh city and 6 kilometers from Iglas town. It lies on $27^{\circ} 45^{\prime} \mathrm{N}$ latitudes and $77^{\circ} 58^{\prime} \mathrm{E}$ longitudes in Iglas block. It covers an area of 217.5 hectares with total population 1,771 constituting 51.95 percent males and 48.05 females. According to Census 2011, the literates are 1075 (60.70 percent to its population). It comprises 281 households. There is one primary school and upper primary school in this village.
24) Kaimawali - It is 4 kilometers away from Iglas block headquarter and approximately 23 kilometers away from district headquarter. It extends on $27^{\circ} 43 \mathrm{~N}$ latitudes and $77^{\circ} 54^{\prime} \mathrm{E}$ longitudes, comprising an area of 219.44 hectares and a total population of 1,535 . The male and female population is 53.35 percent and 46.64 percent respectively. According to 2011 Census, there are 270 households and 921 literates ( 60 percent to total population of this village). There is one secondary school in this village.

### 7.2 Age Composition of Respondents

In the process of agricultural development, the age compositions of respondents play a significant role in adoption of new ideas and practices. It has been observed that the younger generation is not interested in occupation of agriculture. The reason is that hard work is required in agriculture and


Figure 7.2
today's young do not want to work hard. With this view, all the respondents have been divided into three categories on the basis of their ages. The data reveals that about 14.81 percent of younger participates in agricultural activities. However the above analysis gives interesting fact that the middle age and old age respondents actively participate in agriculture rather than younger. The age group consisting 41-55 years accounts 43.91 percent respondents whereas 56-70 years age group constitutes 41.28 percent respondents. Most of the farmers complain that their children do not work in field. It is crucial that the younger are not interested to take agriculture as a main occupation, therefore they are not actively participated in agricultural practices.

### 7.3 Educational Level of Respondents


#### Abstract

A detailed account of educational levels in selected villages is given in table 7.2. It is seen from this table that 87.55 percent are literate respondents while rest 12.45 percent are illiterates. Out of total respondents, about one forth respondents have up to secondary 

Figure 7.3


 level education while one fifth respondents have education up to senior secondary level.Table 7.2 indicates that 14.15 percent and 16.12 percent respondents have education primary and upper primary level respectively. About 8.91 percent respondents and only 2.62 respondents have education up to graduates and postgraduates levels respectively. It has been observed that high level of illiterates have been found in interior villages where no primary school existed. The higher education has been observed in those villages which are located near to city or town and have good accessibility. The village wise education level has been discussed below:

Table 7.2
Educational Status of Respondents in Selected Villages of Aligarh District, 2016
(Figures in percent)

| S.No. | Villages | Illiterate | Literates |  |  |  |  |  | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Primary | Upper Primary | Secondary | Senior Secondary | Graduate | Post Graduate |  |
| 1. | Takipur | 16.67 | 11.11 | 16.67 | 25.00 | 19.44 | 11.11 | 0.00 | 36 |
| 2. | Hetalpur | 2.70 | 5.41 | 5.41 | 27.03 | 45.95 | 10.81 | 2.70 | 37 |
| 3. | Elampura | 8.57 | 11.43 | 14.29 | 28.57 | 34.29 | 2.86 | 0.00 | 35 |
| 4. | Markhi | 8.33 | 16.67 | 20.83 | 29.17 | 20.83 | 4.17 | 0.00 | 24 |
| 5. | Ainchana | 2.70 | 18.92 | 13.51 | 32.43 | 21.62 | 8.11 | 2.70 | 37 |
| 6. | Kasison | 8.11 | 16.22 | 10.81 | 21.62 | 21.62 | 10.81 | 8.11 | 37 |
| 7. | Tejpur | 23.33 | 26.67 | 16.67 | 6.67 | 16.67 | 6.67 | 3.33 | 30 |
| 8. | Faridpur | 18.75 | 25.00 | 12.50 | 21.88 | 15.63 | 0.00 | 6.25 | 32 |
| 9. | Luosara Bisawan | 10.34 | 17.24 | 10.34 | 6.90 | 24.14 | 24.14 | 6.90 | 29 |
| 10. | Kaithwari | 10.71 | 7.14 | 25.00 | 21.43 | 17.86 | 17.86 | 0.00 | 28 |
| 11. | Boner | 16.13 | 9.68 | 6.45 | 35.48 | 19.35 | 12.90 | 0.00 | 31 |
| 12. | Pikhlauni | 9.38 | 6.25 | 15.63 | 50.00 | 15.63 | 3.13 | 0.00 | 32 |
| 13. | Bistauli | 18.92 | 21.62 | 18.92 | 24.32 | 13.51 | 2.70 | 0.00 | 37 |
| 14. | Khurrampur | 17.65 | 20.59 | 17.65 | 20.59 | 17.65 | 5.88 | 0.00 | 34 |
| 15. | Pilkhuni | 7.41 | 3.70 | 25.93 | 29.63 | 22.22 | 11.11 | 0.00 | 27 |
| 16. | Govali | 3.45 | 17.24 | 20.69 | 27.59 | 13.79 | 17.24 | 0.00 | 29 |
| 17. | Taraichi | 15.15 | 18.18 | 15.15 | 27.27 | 15.15 | 9.09 | 0.00 | 33 |
| 18. | Alipur | 24.24 | 18.18 | 18.18 | 15.15 | 18.18 | 6.06 | 0.00 | 33 |
| 19. | Makhdum Nagar | 32.14 | 21.43 | 14.29 | 17.86 | 10.71 | 3.57 | 0.00 | 28 |
| 20. | Rahmapur | 9.68 | 12.90 | 12.90 | 29.03 | 16.13 | 9.68 | 9.68 | 31 |
| 21. | Ektajpur | 12.12 | 15.15 | 3.03 | 27.27 | 24.24 | 9.09 | 9.09 | 33 |
| 22. | Gidaura | 14.29 | 25.71 | 20.00 | 22.86 | 14.29 | 2.86 | 0.00 | 35 |
| 23. | Taharpur | 17.86 | 7.14 | 28.57 | 14.29 | 10.71 | 17.86 | 3.57 | 28 |
| 24. | Kaimawali | 11.11 | 7.41 | 22.22 | 25.93 | 11.11 | 11.11 | 11.11 | 27 |
|  | Total | 12.45 | 14.15 | 16.12 | 25.69 | 19.79 | 9.17 | 2.62 | 763 |

Source: Based on data obtained from field survey, 2016


Figure 7.4

Illiterates- The high percentage of illiteracy has been found in Tejpur, Faridpur, Bistauli, Khurrampur, Alipur, Makhdum Nagar and Taharpur whereas the low literacy has been registered in nine villages, namely, Hetalpur, Elampura, Markhi, Ainchana, Kasison, Pikhlauni, Pilkhuni, Govali, and Rahmapur out of which Hetalpur has lowest illiterates i.e. 2.70 percent. The medium level illiterates have been observed in Takipur, Luosara Bisawan, Kaithwari, Boner, Taraichi, Ektajpur, Gidaura and Kaimawali.

Primary- The primary education has been recorded as high in Ainchana, Tejpur, Faridpur, Bistauli, Khurrampur, Makhdum Nagar, Gidaura whereas it is medium in Markhi, Kasison, Luosara Bisawan, Govali, Taraichi, Alipur, Rahmapur and Ektajpur. The low primary education has been confined in Takipur, Hetalpur, Elampura, Kaithwari, Boner, Pikhlauni, Pilkhuni, Taharpur, and Kaimawali.

Upper primary- The high percentage of upper primary education has been observed in seven villages, namely, Markhi, Kaithwari, Pilkhuni, Govali, Gidaura, Taharpur, Kaimawali whereas the low percentage has been marked in seven villages i.e. Hetalpur, Kasison, Faridpur, Luosara Bisawan, Boner, Rahmapur, and Ektajpur. Remaining ten villages have medium upper primary education.

Secondary- There are six villages, namely, Markhi, Ainchana, Boner, Pikhlauni, Pilkhuni, and Rahmapur which have high secondary education and five villages, namely, Tejpur, Luosara Bisawan, Alipur, Makhdum Nagar, and Taharpur have low secondary education. Remaining thirteen villages have medium percentage of secondary education.

Senior Secondary- There are only four villages which have high education up to senior secondary. They are Hetalpur, Elampura, Luosara Bisawan, and Ektajpur. Out of 24 villages, 13 villages have medium level of senior secondary education and low level of senior secondary education has been registered in seven villages i.e. Bistauli, Govali, Taraichi, Makhdum Nagar, Gidaura, Taharpur, and Kaimawali.

Graduate- The highest percentage of graduates has been noticed in Govali, followed by Luosara Bisawan, Kaithwari, Boner, Govali, and Taharpur. The medium level of graduates has been observed in Takipur, Hetalpur, Ainchana, Kasison, Tejpur, Pilkhuni,

Taraichi, Rahmapur, Ektajpur, and Kaimawali whereas the low graduates has been found in eight villages, namely, Elampura, Markhi, Pikhlauni, Bistauli, Khurrampur, Alipur, Makhdum Nagar, Gidaura. There is no graduate in Faridpur village.

Post Graduates- Out of 24 villages, postgraduates were found in only 10 villages. The village of Taharpur accounted only 11.11 percent postgraduate whereas Rahmapur, Ektajpur, and Kasison accounted between 8-10 percent postgraduates and others. Table 7.2 represents that there are four villages, namely, Hetalpur, Ainchana, Tejpur, and Taharpur where 1 respondent has been found in each village. The interesting result is that the respondents having higher education are not interested in agriculture. They do not want to work themselves in agriculture occupation.

### 7.4 Size of Operational Land Holdings

The distribution of the sample respondents according to the size of their operational land holdings is depicted in table 7.3. The operational land holding is defined as all land either owned or self-operated and leased out from others for cultivation. Due to increasing pressure of population on land, the land is fragmented into small pieces of land. Pal (1992) analyzed that use of fertilizers and agricultural implements is highly depend upon size of land holding. The large farmers have capacity to take risk in adopting any new technology and they have sufficient money to invest in agricultural fields. This table shows that out of 763 respondents, only 4 farmers ( 0.52 percent to total respondents) have operational land holdings more than 10 hectares. They covered 3.29 percent of the total land holdings of sampled households. About 10.22 percent respondents belonged to medium land holdings covered 26.97 percent area of total land holdings and about 26.61 percent of respondents fall in the category of semi-medium who covered maximum area of total holdings i.e. 36.82 percent. The small land holdings covered 29.88 percent to the respondents and 23.03 percent to total land holdings. The largest no. of respondents ( 32.77 percent) fall in the category of marginal holding covered only 9.89 percent area of total holding. The small and marginal farmers are unable to adopt effective utilization of agricultural practices and have little agricultural implements. The small and marginal farmers get no benefits from agricultural policies.

Table 7.3
Number and Size of Land Holding in Selected Villages of Aligarh District, 2016

| S. | Villages | $\begin{gathered} \text { Large } \\ (>10) \text { hectares } \end{gathered}$ |  | $\begin{gathered} \text { Medium } \\ (4-10) \text { hectares } \end{gathered}$ |  | Semi-Medium (2-4) hectares |  | $\begin{gathered} \text { Small } \\ (1-2) \text { hectares } \end{gathered}$ |  | Marginal (<1) hectares |  | Total |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | No. | Area | No. | Area | No. | Area | No. | Area | No. | Area | No. | Area |
| 1. | Takipur | $\begin{gathered} 1 \\ (2.78) \\ \hline \end{gathered}$ | $\begin{gathered} \hline 16.00 \\ (19.59) \\ \hline \end{gathered}$ | $\begin{gathered} \hline 4 \\ (11.11) \\ \hline \end{gathered}$ | $\begin{gathered} 17.76 \\ (21.74) \\ \hline \end{gathered}$ | $\begin{gathered} 11 \\ (30.56) \\ \hline \end{gathered}$ | $\begin{gathered} \hline 26.40 \\ (32.32) \\ \hline \end{gathered}$ | $\begin{gathered} 11 \\ (30.56) \\ \hline \end{gathered}$ | $\begin{gathered} \hline 17.20 \\ (21.06) \\ \hline \end{gathered}$ | $\begin{gathered} 9 \\ (25.00) \\ \hline \end{gathered}$ | $\begin{gathered} 4.32 \\ (5.29) \\ \hline \end{gathered}$ | $\begin{gathered} \hline 36 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & \hline 81.68 \\ & (100) \\ & \hline \end{aligned}$ |
| 2. | Hetalpur | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 8 \\ (21.62) \\ \hline \end{gathered}$ | $\begin{gathered} 45.20 \\ (50.68) \\ \hline \end{gathered}$ | $\begin{gathered} 10 \\ (27.03) \end{gathered}$ | $\begin{gathered} 25.58 \\ (28.68) \\ \hline \end{gathered}$ | $\begin{gathered} 9 \\ (24.32) \\ \hline \end{gathered}$ | $\begin{gathered} 12.72 \\ (14.26) \\ \hline \end{gathered}$ | $\begin{gathered} 10 \\ (27.03) \\ \hline \end{gathered}$ | $\begin{gathered} 5.68 \\ (6.37) \\ \hline \end{gathered}$ | $\begin{gathered} 37 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 89.18 \\ & (100) \\ & \hline \end{aligned}$ |
| 3. | Elampura | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \end{gathered}$ | $\begin{gathered} 3 \\ (8.57) \end{gathered}$ | $\begin{gathered} 13.84 \\ (19.75) \end{gathered}$ | $\begin{gathered} 10 \\ (28.57) \end{gathered}$ | $\begin{gathered} 28.88 \\ (41.21) \end{gathered}$ | $\begin{gathered} 14 \\ (40.00) \end{gathered}$ | $\begin{gathered} 22.32 \\ (31.85) \end{gathered}$ | $\begin{gathered} 8 \\ (22.86) \end{gathered}$ | $\begin{gathered} 5.04 \\ (7.19) \\ \hline \end{gathered}$ | $\begin{gathered} 35 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 70.08 \\ & (100) \end{aligned}$ |
| 4. | Markhi | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 2 \\ (8.33) \end{gathered}$ | $\begin{gathered} 9.20 \\ (20.54) \end{gathered}$ | $\begin{gathered} 5 \\ (20.83) \end{gathered}$ | $\begin{gathered} 12.23 \\ (27.31) \\ \hline \end{gathered}$ | $\begin{gathered} 8 \\ (33.33) \\ \hline \end{gathered}$ | $\begin{gathered} 18.88 \\ (42.15) \\ \hline \end{gathered}$ | $\begin{gathered} 9 \\ (37.50) \\ \hline \end{gathered}$ | $\begin{gathered} 4.48 \\ (10.00) \\ \hline \end{gathered}$ | $\begin{gathered} 24 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & \hline 44.79 \\ & (100) \\ & \hline \end{aligned}$ |
| 5. | Ainchana | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \end{gathered}$ | $\begin{gathered} 5 \\ (13.51) \end{gathered}$ | $\begin{gathered} 24.56 \\ (32.20) \end{gathered}$ | $\begin{gathered} 11 \\ (29.73) \end{gathered}$ | $\begin{gathered} 27.60 \\ (36.18) \end{gathered}$ | $\begin{gathered} 12 \\ (32.43) \end{gathered}$ | $\begin{gathered} 19.52 \\ (25.59) \end{gathered}$ | $\begin{gathered} 9 \\ (24.32) \end{gathered}$ | $\begin{gathered} 4.60 \\ (6.03) \\ \hline \end{gathered}$ | $\begin{gathered} 37 \\ (100) \end{gathered}$ | $\begin{aligned} & 76.28 \\ & (100) \end{aligned}$ |
| 6. | Kasison | $\begin{gathered} 1 \\ (2.70) \end{gathered}$ | $\begin{gathered} 10.88 \\ (12.57) \end{gathered}$ | $\begin{gathered} 4 \\ (10.81) \end{gathered}$ | $\begin{gathered} 18.32 \\ (21.16) \end{gathered}$ | $\begin{gathered} 15 \\ (40.54) \end{gathered}$ | $\begin{gathered} 39.84 \\ (46.03) \end{gathered}$ | $\begin{gathered} 9 \\ (24.32) \end{gathered}$ | $\begin{gathered} 12.56 \\ (14.51) \end{gathered}$ | $\begin{gathered} 8 \\ (21.62) \end{gathered}$ | $\begin{gathered} 4.96 \\ (5.73) \end{gathered}$ | $\begin{gathered} 37 \\ (100) \end{gathered}$ | $\begin{aligned} & 86.56 \\ & (100) \\ & \hline \end{aligned}$ |
| 7. | Tejpur | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 1 \\ (3.33) \\ \hline \end{gathered}$ | $\begin{gathered} \hline 4.00 \\ (9.12) \\ \hline \end{gathered}$ | $\begin{gathered} 7 \\ (23.33) \\ \hline \end{gathered}$ | $\begin{array}{r} 18.40 \\ (41.97) \\ \hline \end{array}$ | $\begin{gathered} 12 \\ (40.00) \\ \hline \end{gathered}$ | $\begin{gathered} 14.32 \\ (32.66) \\ \hline \end{gathered}$ | $\begin{gathered} 10 \\ (33.33) \\ \hline \end{gathered}$ | $\begin{gathered} 7.12 \\ (16.24) \\ \hline \end{gathered}$ | $\begin{gathered} 30 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 43.84 \\ & (100) \\ & \hline \end{aligned}$ |
| 8. | Faridpur | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 1 \\ (3.13) \\ \hline \end{gathered}$ | $\begin{gathered} 4.00 \\ (8.39) \\ \hline \end{gathered}$ | $\begin{gathered} 10 \\ (31.25) \\ \hline \end{gathered}$ | $\begin{array}{r} 22.96 \\ (48.15) \\ \hline \end{array}$ | $\begin{gathered} 8 \\ (25.00) \\ \hline \end{gathered}$ | $\begin{array}{r} 11.68 \\ (24.50) \\ \hline \end{array}$ | $\begin{gathered} 13 \\ (40.63) \\ \hline \end{gathered}$ | $\begin{gathered} 9.04 \\ (18.96) \\ \hline \end{gathered}$ | $\begin{gathered} 32 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 47.68 \\ & (100) \end{aligned}$ |
| 9. | Luosara Bisawan | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 2 \\ (6.90) \end{gathered}$ | $\begin{gathered} 8.00 \\ (18.38) \end{gathered}$ | $\begin{gathered} 3 \\ (10.34) \end{gathered}$ | $\begin{gathered} 10.00 \\ (22.98) \end{gathered}$ | $\begin{gathered} 14 \\ (48.28) \\ \hline \end{gathered}$ | $\begin{gathered} 19.76 \\ (45.40) \end{gathered}$ | $\begin{gathered} 10 \\ (34.48) \end{gathered}$ | $\begin{gathered} 5.76 \\ (13.24) \end{gathered}$ | $\begin{gathered} 29 \\ (100) \end{gathered}$ | $\begin{aligned} & 43.52 \\ & (100) \\ & \hline \end{aligned}$ |
| 10. | Kaithwari | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 3 \\ (10.71) \end{gathered}$ | $\begin{gathered} 15.50 \\ (24.87) \end{gathered}$ | $\begin{gathered} 9 \\ (32.14) \end{gathered}$ | $\begin{gathered} 31.00 \\ (49.74) \end{gathered}$ | $\begin{gathered} 7 \\ (25.00) \\ \hline \end{gathered}$ | $\begin{gathered} 11.56 \\ (18.55) \\ \hline \end{gathered}$ | $\begin{gathered} 9 \\ (32.14) \end{gathered}$ | $\begin{gathered} 4.26 \\ (6.84) \\ \hline \end{gathered}$ | $\begin{gathered} 28 \\ (100) \end{gathered}$ | $\begin{aligned} & 62.32 \\ & (100) \\ & \hline \end{aligned}$ |
| 11. | Boner | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \end{gathered}$ | $\begin{gathered} 2 \\ (6.45) \end{gathered}$ | $\begin{gathered} 15.28 \\ (33.99) \end{gathered}$ | $\begin{gathered} 5 \\ (16.13) \end{gathered}$ | $\begin{gathered} 12.40 \\ (27.58) \end{gathered}$ | $\begin{gathered} 9 \\ (29.03) \end{gathered}$ | $\begin{gathered} 11.36 \\ (25.27) \end{gathered}$ | $\begin{gathered} 15 \\ (48.39) \end{gathered}$ | $\begin{gathered} 5.92 \\ (13.17) \end{gathered}$ | $\begin{gathered} 31 \\ (100) \end{gathered}$ | $\begin{aligned} & 44.96 \\ & (100) \end{aligned}$ |
| 12. | Pikhlauni | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 7 \\ (21.88) \\ \hline \end{gathered}$ | $\begin{array}{r} 31.68 \\ (40.70) \\ \hline \end{array}$ | $\begin{gathered} 15 \\ (46.88) \\ \hline \end{gathered}$ | $\begin{array}{r} 37.44 \\ (48.10) \\ \hline \end{array}$ | $\begin{gathered} 3 \\ (9.38) \\ \hline \end{gathered}$ | $\begin{gathered} 4.48 \\ (5.76) \\ \hline \end{gathered}$ | $\begin{array}{r} 7 \\ (21.88) \\ \hline \end{array}$ | $\begin{gathered} 4.24 \\ (5.45) \\ \hline \end{gathered}$ | $\begin{gathered} 32 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 77.84 \\ & (100) \\ & \hline \end{aligned}$ |

Continue...

| 13. | Bistauli | $\begin{gathered} 1 \\ (2.70) \end{gathered}$ | $\begin{gathered} 10.80 \\ (12.84) \end{gathered}$ | $\begin{gathered} 7 \\ (18.92) \end{gathered}$ | $\begin{gathered} \hline 30.64 \\ (36.44) \end{gathered}$ | $\begin{gathered} 8 \\ (21.62) \end{gathered}$ | $\begin{gathered} 21.12 \\ (25.12) \end{gathered}$ | $\begin{gathered} 11 \\ (29.73) \end{gathered}$ | $\begin{gathered} \hline 16.88 \\ (20.08) \end{gathered}$ | $\begin{gathered} 10 \\ (27.03) \end{gathered}$ | $\begin{gathered} 4.64 \\ (5.52) \end{gathered}$ | $\begin{gathered} 37 \\ (100) \end{gathered}$ | $\begin{aligned} & 84.08 \\ & (100) \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 14. | Khurrampur | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 5 \\ (14.71) \\ \hline \end{gathered}$ | $\begin{gathered} 22.32 \\ (34.44) \\ \hline \end{gathered}$ | $\begin{gathered} 9 \\ (26.47) \\ \hline \end{gathered}$ | $\begin{gathered} 21.60 \\ (33.33) \\ \hline \end{gathered}$ | $\begin{gathered} 11 \\ (32.35) \end{gathered}$ | $\begin{gathered} 15.84 \\ (24.44) \\ \hline \end{gathered}$ | $\begin{gathered} 9 \\ (26.47) \\ \hline \end{gathered}$ | $\begin{gathered} 5.04 \\ (7.78) \\ \hline \end{gathered}$ | $\begin{gathered} 34 \\ (100) \\ \hline \end{gathered}$ | $\begin{gathered} 64.8 \\ (100) \\ \hline \end{gathered}$ |
| 15. | Pilkhuni | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00 \mathrm{v} \end{gathered}$ | $\begin{gathered} 1 \\ (3.70) \end{gathered}$ | $\begin{gathered} 4.16 \\ (13.27) \end{gathered}$ | $\begin{gathered} 2 \\ (7.41) \end{gathered}$ | $\begin{gathered} 4.80 \\ (15.31) \end{gathered}$ | $\begin{gathered} 8 \\ (29.63) \end{gathered}$ | $\begin{gathered} 10.88 \\ (34.69) \end{gathered}$ | $\begin{gathered} 16 \\ (59.26) \end{gathered}$ | $\begin{gathered} 11.52 \\ (36.73) \end{gathered}$ | $\begin{gathered} 27 \\ (100) \end{gathered}$ | $\begin{aligned} & 31.36 \\ & (100) \end{aligned}$ |
| 16. | Govali | $\begin{gathered} 1 \\ (3.45) \end{gathered}$ | $\begin{gathered} 10.10 \\ (17.32) \end{gathered}$ | $\begin{gathered} 3 \\ (10.34) \end{gathered}$ | $\begin{gathered} 17.92 \\ (30.73) \end{gathered}$ | $\begin{gathered} 8 \\ (27.59) \end{gathered}$ | $\begin{gathered} 13.82 \\ (23.70) \end{gathered}$ | $\begin{gathered} 7 \\ (24.14) \end{gathered}$ | $\begin{gathered} 9.84 \\ (16.87) \end{gathered}$ | $\begin{gathered} 10 \\ (34.48) \end{gathered}$ | $\begin{gathered} 6.64 \\ (11.39) \end{gathered}$ | $\begin{gathered} 29 \\ (100) \end{gathered}$ | $\begin{aligned} & 58.32 \\ & (100) \end{aligned}$ |
| 17. | Taraichi | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 1 \\ (3.03) \end{gathered}$ | $\begin{gathered} 6.40 \\ (18.07) \end{gathered}$ | $\begin{gathered} 3 \\ (9.09) \end{gathered}$ | $\begin{gathered} 7.28 \\ (20.55) \end{gathered}$ | $\begin{gathered} 9 \\ (27.27) \end{gathered}$ | $\begin{gathered} 11.28 \\ (31.85) \end{gathered}$ | $\begin{gathered} 20 \\ (60.61) \end{gathered}$ | $\begin{gathered} 10.46 \\ (29.53) \end{gathered}$ | $\begin{gathered} 33 \\ (100) \end{gathered}$ | $\begin{aligned} & 35.42 \\ & (100) \end{aligned}$ |
| 18. | Alipur | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 1 \\ (3.03) \\ \hline \end{gathered}$ | $\begin{gathered} 4.10 \\ (10.40) \\ \hline \end{gathered}$ | $\begin{gathered} 3 \\ (9.09) \\ \hline \end{gathered}$ | $\begin{gathered} 8.08 \\ (20.49) \\ \hline \end{gathered}$ | $\begin{gathered} 12 \\ (36.36) \\ \hline \end{gathered}$ | $\begin{gathered} 16.04 \\ (40.67) \\ \hline \end{gathered}$ | $\begin{gathered} 17 \\ (51.52) \\ \hline \end{gathered}$ | $\begin{gathered} 11.22 \\ (28.45) \\ \hline \end{gathered}$ | $\begin{gathered} 33 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 39.44 \\ & (100) \\ & \hline \end{aligned}$ |
| 19. | Makhdum Nagar | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 2 \\ (7.14) \\ \hline \end{gathered}$ | $\begin{gathered} 11.20 \\ (21.47) \\ \hline \end{gathered}$ | $\begin{gathered} 7 \\ (25.00 \mathrm{v} \\ \hline \end{gathered}$ | $\begin{gathered} 19.84 \\ (38.04) \\ \hline \end{gathered}$ | $\begin{gathered} 10 \\ (35.71) \\ \hline \end{gathered}$ | $\begin{gathered} 15.52 \\ (29.75) \\ \hline \end{gathered}$ | $\begin{gathered} 9 \\ (32.14) \\ \hline \end{gathered}$ | $\begin{gathered} 5.60 \\ (10.74) \\ \hline \end{gathered}$ | $\begin{gathered} 28 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 52.16 \\ & (100) \\ & \hline \end{aligned}$ |
| 20. | Rahmapur | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 2 \\ (6.45) \end{gathered}$ | $\begin{gathered} 9.60 \\ (16.04) \end{gathered}$ | $\begin{gathered} 12 \\ (38.71) \end{gathered}$ | $\begin{gathered} 34.16 \\ (57.09) \end{gathered}$ | $\begin{gathered} 7 \\ (22.58) \end{gathered}$ | $\begin{gathered} 10.56 \\ (17.65) \end{gathered}$ | $\begin{gathered} 10 \\ (32.26) \end{gathered}$ | $\begin{gathered} 5.52 \\ (9.22) \\ \hline \end{gathered}$ | $\begin{gathered} 31 \\ (100) \end{gathered}$ | $\begin{aligned} & 59.84 \\ & (100) \end{aligned}$ |
| 21. | Ektajpur | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \end{gathered}$ | $\begin{gathered} 4 \\ (12.12) \end{gathered}$ | $\begin{gathered} 27.28 \\ (31.17) \end{gathered}$ | $\begin{gathered} 17 \\ (51.52) \end{gathered}$ | $\begin{gathered} 47.92 \\ (54.75) \end{gathered}$ | $\begin{gathered} 6 \\ (18.18) \end{gathered}$ | $\begin{gathered} 9.28 \\ (10.60) \end{gathered}$ | $\begin{gathered} 6 \\ (18.18) \end{gathered}$ | $\begin{gathered} 3.04 \\ (3.47) \end{gathered}$ | $\begin{gathered} 33 \\ (100) \end{gathered}$ | $\begin{aligned} & 87.52 \\ & (100) \end{aligned}$ |
| 22. | Gidaura | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 3 \\ (8.57) \\ \hline \end{gathered}$ | $\begin{gathered} 15.60 \\ (26.12) \end{gathered}$ | $\begin{gathered} 7 \\ (20.00) \end{gathered}$ | $\begin{gathered} 23.12 \\ (38.71) \end{gathered}$ | $\begin{gathered} 12 \\ (34.29) \end{gathered}$ | $\begin{gathered} 14.64 \\ (24.51) \end{gathered}$ | $\begin{gathered} 13 \\ (37.14) \end{gathered}$ | $\begin{gathered} 6.36 \\ (10.65) \end{gathered}$ | $\begin{gathered} 35 \\ (100) \end{gathered}$ | $\begin{aligned} & 59.72 \\ & (100) \end{aligned}$ |
| 23. | Taharpur | $\begin{gathered} 0 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 4 \\ (14.29) \end{gathered}$ | $\begin{gathered} 18.16 \\ (35.25) \\ \hline \end{gathered}$ | $\begin{gathered} 4 \\ (14.29) \\ \hline \end{gathered}$ | $\begin{gathered} 10.64 \\ (20.65) \\ \hline \end{gathered}$ | $\begin{gathered} 13 \\ (46.43) \\ \hline \end{gathered}$ | $\begin{gathered} 18.24 \\ (35.40) \\ \hline \end{gathered}$ | $\begin{gathered} 7 \\ (25.00) \\ \hline \end{gathered}$ | $\begin{gathered} 4.48 \\ (8.70) \\ \hline \end{gathered}$ | $\begin{gathered} 28 \\ (100) \\ \hline \end{gathered}$ | $\begin{aligned} & 51.52 \\ & (100) \end{aligned}$ |
| 24. | Kaimawali | $\begin{gathered} 0 \\ (0.00) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.00) \\ \hline \end{gathered}$ | $\begin{gathered} 3 \\ (11.11) \\ \hline \end{gathered}$ | $\begin{gathered} 17.28 \\ (28.57) \\ \hline \end{gathered}$ | $\begin{gathered} 12 \\ (44.44) \end{gathered}$ | $\begin{gathered} 30.00 \\ (49.60) \\ \hline \end{gathered}$ | $\begin{gathered} 6 \\ (22.22) \end{gathered}$ | $\begin{gathered} 9.36 \\ (15.48) \end{gathered}$ | $\begin{gathered} 6 \\ (22.22) \end{gathered}$ | $\begin{gathered} 3.84 \\ (6.35) \\ \hline \end{gathered}$ | $\begin{gathered} 27 \\ (100) \end{gathered}$ | $\begin{aligned} & 60.48 \\ & (100) \end{aligned}$ |
|  | Total | $\begin{gathered} 4 \\ (0.52) \end{gathered}$ | $\begin{aligned} & 47.78 \\ & (3.29) \\ & \hline \end{aligned}$ | $\begin{gathered} 78 \\ (10.22) \\ \hline \end{gathered}$ | $\begin{aligned} & 392.00 \\ & (26.97) \end{aligned}$ | $\begin{gathered} 203 \\ (26.61) \end{gathered}$ | $\begin{aligned} & 535.11 \\ & (36.82) \end{aligned}$ | $\begin{gathered} 228 \\ (29.88) \end{gathered}$ | $\begin{aligned} & 334.72 \\ & (23.03) \end{aligned}$ | $\begin{gathered} 250 \\ (32.77) \end{gathered}$ | $\begin{gathered} 143.78 \\ (9.89) \\ \hline \end{gathered}$ | $\begin{gathered} 763 \\ (100) \end{gathered}$ | $\begin{gathered} 1453.39 \\ (100) \\ \hline \end{gathered}$ |

Sources: Based on data obtained from field survey, 2016
Note- The figures in brackets is shown in percentage

## Large holdings (above 10 hectare)

There are only four villages namely Takipur, Govali, Bistauli and Kasison, which have large holdings possesses 19.59 percent, 17.32 percent, 12.84 percent and 12.57 percent area of total holdings respectively. After the act of land ceiling, the farmers have not beyond 5.6 hectares land. But some farmers hire farm lands from those land owners who give their land on rent or sharing.

## Medium holdings (4 to 10 hectare)

The highest percentage of medium land holdings has been observed in Pikhlauni (21.88), followed by Hetalpur (21.62), Bistauli (18.92), Khurrampur (14.71), Taharpur (14.29) and Ainchana (13.50) which cover between $30-50$ percent area of total land holdings. It is seen from the table 7.3 that there are nine villages, namely, Takipur, Elampura, Markhi, Kasison, Kaithwari, Govali, Ektajpur, Gidaura and Kaimawali which have 8 to 12 percent of medium holdings, possess 20 to 30 percent area of land holdings. The low size of medium land holders (below 7 percent) are confined in Tejpur, Faridpur, Luosara Bisawan, Boner, Pilkhuni, Taraichi, Alipur, Makhdum Nagar, and Rahmapur which cover below 20 percent area of land holdings except Boner. Boner village has only 6.45 percent of medium land holders but it possess 33.99 percentage area of land holdings.

Below 10 percent medium land holders have been found in Elampura, Gidaura, Markhi, Luosara Bisawan, Boner, Makhdum Nagar, Rahmapur, Pilkhuni, Tejpur, Faridpur, Taraichi and Alipur which cover 19.75 percent, 26.12 percent, 20.54 percent, 18.38 percent, 33.99 percent, 21.47 percent, 16.04 percent, 13.27 percent, 9.12 percent, 8.39 percent, 18.07 percent and 10.40 percent area to total land holdings respectively.

## Semi medium holdings (2 to 4 hectare)

It is seen from the table 7.3 that the highest percentage of semi-medium land holdings have been observed in Ektajpur ( 51.52 percent), followed by Pikhlauni (46.88 percent), Kaimawali (44.44 percent), Kasison (40.54 percent) and Rahmapur


Figure 7.5
(38.71 percent) which cover 54.75 percent, 48.10 percent, 49.60 percent, 46.03 percent and 57.09 percent area respectively. This table indicates that there are 13 villages which have 20-32 percent of semi-medium land holders, cover 20-50 percent area of total holding. The percentage of semi-medium land holdings is low in Pilkhuni (7.41 percent), followed by Taraichi (9.09), Alipur(9.09), Luosara Bisawan (10.34 Percent) and Boner (16.13 Percent) which record 15.31 percent, 20.55 percent, 20.49 percent, 22.98 percent and 27.58 percent area respectively.

## Small holdings (1 to 2 hectare)

The high percentage of small land holdings has been observed in six villages i.e. Elampura, Tejpur, Luosara Bisawan, Alipur, Makhdum Nagar and Taharpur. These six villages have more than 35 percent of small holders and area. Table 7.3 indicates there are ten villages which have medium level (between 25-30 percent) of small land holders. The low percentage of small land holders (below 25 percent) has been noticed in Hetalpur, Kasison, Faridpur, Kaithwari, Govali, Rahmapur, Ektajpur, and Kaimawali which cover between 10 to 25 percent area of land holding. The lowest percentage in term of number and area has been recorded in Pikhlauni village i.e. 9.38 percent and 5.76 percent respectively.

## Marginal holdings (less than 1 hectare)

It is seen from the table 7.3 that the marginal land holders (above 39 percent) are high in five villages i.e. Faridpur, Boner, Pilkhuni, Taraichi, and Alipur which cover 1337 percent area of land holding. The medium marginal holders (between 27-39 percent) have been registered in Markhi, Tejpur, Luosara Bisawan, Kaithwari, Govali, Makhdum Nagar, and Rahmapur which cover 5-16 percent area of land holding. The low marginal holders have been observed in eleven villages which cover below 9 percent area of land holding.

### 7.5 Cropping pattern

Cropping pattern is defined as the quality of crops grown usually on a plot of land during a particular agricultural year (Verma, 1993). It is influenced by a number of
factors such as climate, soil quality, size of land holding, availability of irrigation facilities, needs of the farmers, labour, public policies and marketing facilities.

The cropping pattern in selected 24 villages can be inferred from the data given in table 7.4 and 7.5 , showing the area under different crops and their percentage to the gross cropped area of selected villages. The gross cropped area of the 24 villages is 3042.88 hectares. There are two main agricultural season; Kharif and Rabi. The Kharif season usually begins in mid-June with the outbreak of the monsoon, while the Rabi season starts in the end of October or early November when the monsoon has receded. The crops of Kharif season are those which need a high temperature and a plentiful supply of water while the Rabi crops require cool weather and moderate supply of water. The major Kharif crops of the study region are Rice, Millet, Maize, Cotton, Pulses (Moong Urad, and Arhar), and Sugarcane. The Rabi crops of study area are Wheat, Barley, Mustard, Potato, Pulses (Masur and Pea) and Vegetables.

## I) KHARIF CROPS

The area under Kharif crops are shown in table 7.4.

## Rice

Rice is the most important staple crop of Kharif season. Rice is dominant crop in those villages where canal irrigation is available because rice cultivation requires high amount of water. Now a day, the farmer is crazy for paddy cultivation in all villages of district because in 2013, the govt. provided good price for rice. After getting good price of rice, the farmers are promoted to cultivate rice, whether the soil is suitable or not, irrigation facilities are good or not for its cultivation. Rice occupies 24.45 percent area to gross cropped area in selected villages as a whole. The highest area under rice has been found in Ainchana (42.67) followed by Bistauli (41.43 percent), Takipur (39.29 percent) and Khurrampur ( 39.00 percent). The Upper Ganges Canal passes through Akrabad block and one canal has also cut from Upper Ganga Canal in Akrabad. Therefore, the water table is high in Bistauli and Khurrampur (located in Akrabad block) and this block has good irrigation facilities. So the farmers easily supply water to rice crops. All farmers of

Bistauli and Khurrampur use pumping sets for irrigation. Every farmer of Bistauli takes water from canal while farmers of Ainchana and Takipur take 70.27 percent and 25.00 percent water from canal. This is the reason for high percentage of area under rice crops in these four villages. Table 7.4 shows that the area under rice is lowest in Luosara Bisawan ( 0.35 percent) followed by Faridpur 7.89 percent. The main reason behind it is poor facilities of irrigation. The rice farming requires hard labour and now young farmers do not work hard in their field because of low benefit in agriculture. The farmers of Luosara Bisawan prefer vegetable farming instead of rice farming. The village is 7 kilometers away from city and it is convenient for farmers to sell their vegetables in the city market and get maximum benefit.

## Millet

The total millet area contributes 11.67 percent to Gross Cropped area of all selected villages. The area under millet is higher in those villages where irrigation facilities are poor. Millet requires less water. Because of sowing millet in kharif season, the rain water is enough for it. In the absence of rain water, one or two irrigation is required at the time of flowering. Therefore, the area under millet is high in Luosara Bisawan, Makhdum Nagar, Kasison, Faridpur and Taharpur, occupy 34.13 percent, 26.19 percent, 25.17 percent, 25.00 percent and 22.87 percent respectively. In these villages the area under rice is low. There is no millet cultivation in Ainchana and Bistauli because they are high in rice cultivation. The lowest area under millet has been found in Markhi (1.25 percent), Govali (2.06 percent), Ektajpur (2.64percent), Pilkhuni ( 2.82 percent) and Alipur ( 2.88 percent). Markhi records low area under millet because after rice, cotton and sugarcane crops are grown in this village whereas Alipur records low in millet area due to high maize area and Ektajpur registers low area due to high area under rice and moong crops.

## Maize

Maize contributes only 1.89 percent area to Gross Cropped Area. Maize is grown systematically with line sowing seeds only in Atrouli tehsil. The line sowing of Maize seed is adopted by farmers recently before 2 years. Only the blocks of Atrouli tehsil have

Table 7.4
Percentage Area under Kharif Crops in Selected Villages of Aligarh District, 2015

| S.No. | Villages/Crops | Rice | Millet | Maize | Cotton | Moong | Urad | Arhar | Sugarcane | Vegetables | Others |
| :---: | :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Takipur | 39.29 | 5.16 | 0.24 | 0.00 | 0.00 | 0.00 | 0.00 | 1.21 | 0.40 | 2.01 |
| 2. | Hetalpur | 28.45 | 12.23 | 0.00 | 1.51 | 2.24 | 0.00 | 0.95 | 0.84 | 0.00 | 1.79 |
| 3. | Elampura | 16.52 | 9.93 | 0.29 | 5.24 | 3.12 | 0.91 | 4.51 | 6.30 | 1.33 | 3.45 |
| 4. | Markhi | 32.19 | 1.25 | 0.00 | 6.48 | 2.95 | 0.00 | 0.63 | 4.02 | 0.00 | 2.50 |
| 5. | Ainchana | 42.67 | 0.00 | 0.49 | 0.00 | 0.64 | 0.00 | 0.42 | 0.49 | 0.00 | 2.37 |
| 6. | Kasison | 19.20 | 25.17 | 0.00 | 0.31 | 0.49 | 0.22 | 0.00 | 0.00 | 0.00 | 3.14 |
| 7. | Tejpur | 25.62 | 8.90 | 2.11 | 0.00 | 1.05 | 0.00 | 0.26 | 7.96 | 0.00 | 2.17 |
| 8. | Faridpur | 7.89 | 25.00 | 5.23 | 0.90 | 1.88 | 1.23 | 2.78 | 0.33 | 0.00 | 3.47 |
| 9. | Luosara Bisawan | 0.35 | 34.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.44 | 0.00 | 7.45 | 5.48 |
| 10. | Kaithwari | 10.86 | 27.49 | 0.00 | 1.76 | 3.06 | 0.00 | 1.39 | 0.00 | 1.76 | 1.82 |
| 11. | Boner | 22.63 | 14.47 | 0.43 | 0.00 | 1.01 | 0.26 | 4.49 | 0.00 | 1.58 | 3.67 |
| 12. | Pikhlauni | 13.05 | 13.16 | 1.71 | 0.00 | 2.00 | 0.00 | 1.12 | 0.00 | 12.00 | 3.29 |
| 13. | Bistauli | 41.43 | 0.00 | 1.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.97 |
| 14. | Khurrampur | 39.00 | 3.43 | 0.00 | 0.00 | 1.62 | 0.00 | 0.00 | 0.00 | 0.00 | 2.78 |
| 15. | Pilkhuni | 12.37 | 2.82 | 4.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 21.53 | 3.01 |
| 16. | Govali | 27.02 | 2.06 | 6.78 | 0.00 | 4.41 | 0.00 | 3.47 | 0.00 | 0.00 | 2.22 |
| 17. | Taraichi | 11.17 | 20.44 | 8.17 | 0.00 | 0.24 | 0.00 | 0.00 | 0.00 | 1.42 | 5.22 |
| 18. | Alipur | 27.85 | 2.88 | 7.98 | 0.00 | 3.36 | 0.00 | 0.00 | 0.00 | 0.00 | 5.31 |
| 19. | Makhdum Nagar | 11.03 | 26.19 | 6.06 | 0.00 | 0.00 | 0.00 | 0.36 | 0.00 | 0.76 | 2.77 |
| 20. | Rahmapur | 26.83 | 11.24 | 3.26 | 0.00 | 2.52 | 0.00 | 0.00 | 0.00 | 0.26 | 4.21 |
| 21. | Ektajpur | 30.45 | 2.64 | 2.90 | 0.00 | 9.21 | 0.00 | 0.00 | 0.00 | 1.23 | 1.16 |
| 22. | Gidaura | 27.85 | 14.27 | 0.00 | 0.00 | 1.60 | 0.00 | 1.31 | 0.00 | 0.00 | 3.01 |
| 23. | Taharpur | 12.88 | 22.87 | 0.00 | 0.00 | 2.41 | 0.00 | 1.50 | 0.00 | 1.20 | 5.10 |
| 24. | Kaimawali | 23.52 | 8.81 | 1.74 | 0.75 | 1.31 | 0.00 | 4.46 | 0.00 | 0.00 | 6.40 |
|  | Total | $\mathbf{2 4 . 4 5}$ | $\mathbf{1 1 . 6 7}$ | $\mathbf{1 . 8 9}$ | $\mathbf{0 . 6 7}$ | $\mathbf{2 . 0 1}$ | $\mathbf{0 . 1 0}$ | $\mathbf{1 . 1 2}$ | $\mathbf{0 . 7 9}$ | $\mathbf{1 . 7 8}$ | $\mathbf{3 . 2 4}$ |

Source: Based on data obtained from field survey, 2016


Figure 7.6


Plate 14.
Rice Cultivation

## Plate 15. Millet Cultivation



Plate 16. Maize Cultivation with Line Sowing Technique
adopted modern techniques of maize cultivation. The highest area under maize has been found in Govali, Alipur, Taraichi, Makhdum Nagar and Faridpur which record above 5-8 percent area to total cropped area. There is no maize cultivation in Hetalpur, Markhi, Kasison, Luosara Bisawan, Kaithwari, Khurrampur, Gidaura and Taharpur. Rest of villages has low area under maize below 5 percent.

## Cotton

Cotton shares only 0.67 percent area to Gross Cropped Area. The area under cotton dominates in Markhi and Elampura villages of Chandaus block. Markhi and Elampura occupy 6.48 percent and 5.24 percent area under cotton respectively. The climatic condition is favorable for cotton cultivation. The water level is low in this block and soil is suitable for cotton. There are 1.76 percent and 1.51 percent area under cotton, found in Kaithwari and Hetalpur respectively. There are three villages namely Kasison, Faridpur and Kaimawali which record below 1 percent area under cotton.

## Pulses

The percentage of pulses is very low in all villages. The Kharif pulses of study region are moong, urad and arhar. The moong, urad and arhar share $2.01,0.10$ and 1.12 percent area in selected villages respectively. The highest area under moong cultivation has been recorded in Ektajpur i.e. 9.21 percent. After it, Govali records 4.41 percent followed by Alipur (3.36), Elampura ( 3.12 percent) and Kaithwari (3.06 percent). There is no area under moong cultivation in Takipur, Luosara Bisawan, Bistauli and Makhdum Nagar whereas others cover below 3 percent area. There is only one village i.e. Faridpur shares only 1.23 percent area under urad. There are three villages namely Elampura, Boner and Kasison which cover only 0.91 percent, 0.26 percent and 0.22 percent area under urad respectively. The highest area under arhar has been registered in Kaimawali (4.46 percent) followed by Elampura (4.51 percent), Boner (4.49 percent) and Faridpur (2.78 percent). There are four villages namely Kaithwari, Pikhlauni, Gidaura and Taharpur which constitute area between 1 percent and 2 percent. There is no area under arhar in Takipur, Kasison, Bistauli, Khurrampur, Pilkhuni, Tarainchi, Alipur, Rahmapur


Plate 17. Urad Cultivation

Plate 18.
Arhar
Cultivation


Plate 19.
Antelopes
in field
and Ektajpur. Remaining six villages namely Hetalpur, Markhi, Ainchana, Tejpur, Luosara Bisawan, and Makhdum Nagar have below 1 percent area under arhar.

The reasons for low cultivation of pulses, firstly, the farmers use poor quality of land and unirrigated land for pulses because pulses require less water. Secondly the pulses are highly susceptible to diseases. Thirdly, there is no availability of high-yielding varieties and certified seeds of pulses. Fourthly, the wild animals damage pulses so the farmers choice other lucrative crops.

## Sugarcane

Sugarcane is an annual crop but it is sowing in Kharif season so it comes under Kharif crops. It covers only 0.79 percent area in selected villages. Now the farmers do not want to cultivate the sugarcane. The first reason behind it, the farmers do not get timely payment for their crops. They are awaited sometimes for one year or more. Secondly, the govt. does not give good price for sugarcane. Therefore the farmers get low return for their crops. Table 7.4 shows that the area under sugarcane is found only in seven villages out of twenty-four villages. These villages are located in the north- eastern part of the district. Tejpur and Faridpur share 7.96 percent and 6.30 percent area to Gross Cropped Area respectively. The area under sugarcane has been shared by Markhi ( 4.02 percent), Takipur (1.21 percent), Hetalpur (0.84 percent) and Ainchana ( 0.49 percent).

## Vegetables

Vegetable farming requires loamy soil, adequate water supply, close to market and good transport facilities. In selected villages, those villages share high percentage area under vegetable which are located neighborhood to the towns. Caste also plays an important role in choosing vegetable farming. It is believed that Vegetable farming is the occupation of the Kanchhi and Mali caste, therefore, general caste do not prefer to grow vegetable. They feel inferiority in selling vegetables along the road or in mandies. Pilkhuni is the only village which shares 21.53 percent. This village is located at a distance from 2.5 km away from Atrouli town. After Pilkhuni, Pikhlauni contributes 12.00 percent and Luosara Bisawan share 7.45 percent area under vegetables. The
farmers sell vegetables in Dhanipur mandi easily. There are Takipur, Elampura, Kaithwari, Boner, Tarainchi, Makhdum Nagar, Rahmapur, Ektajpur and Gidaura which cover below 2 percent area under vegetables. These villages are located along the road and the villages along the road also determine the vegetable cropping. The farmers sit along the road for selling the vegetables.

## Others

Every farmer cultivates fodder in one or two bigha of land for feeding the animals. The farming of rose are cultivated in Bistauli village and the farmers sell flowers to Hasayanpur. Factory of rose product is located in Hasayanpur. Mentha has also been found in Bistauli and Alipur because of wet land. Mentha firm is located in Vijaygarh town which is nearest to Bistauli village.

## II- RABI CROPS

The area under Rabi crops in selected villages is depicted in table 7.5.

## Wheat

Wheat is the main crop in all villages because of main dietary habits of people in study area. Mostly, wheat is sowing after the rice cultivation. For the good yield of wheat, it is necessary to timely sowing of rice. Wheat is grown in clay loam, good structure and moderate water holding capacity of soil. Wheat is required 5-6 irrigation in whole period. The condition of water logging is not suitable for wheat cultivation. Out of total 47.06 percent area of Rabi to gross cropped area, wheat shares 29.87 percent area to total gross cropped area. The highest area under wheat has been found in Khurrampur (41.27 percent), followed by Bistauli (40.41 percent), Hetalpur ( 39.75 percent). Table 7.5 indicates that there are ten villages namely Takipur, Markhi, Kasison, Tejpur, Faridpur, Govali, Tarainchi, Alipur, Makhdum Nagar and Rahmapur which share between 30-40 percent area under wheat while eight villages namely Elampura, Ainchana, Luosara Bisawan, Kaithwari, Boner, Pikhlauni, Ektajpur and Gidaura contribute between 20-30 percent areas under wheat. The lowest percentage share of wheat has been recorded in Pilkhuni (10.30 percent), Taharpur (14.23 percent) and Kaimawali (17.77).

Table 7.5
Percentage Area under Rabi Crops in Selected Villages of Aligarh District, 2016

| S. No. | Villages/Crops | Wheat | Barley | Mustard | Potato | Masur | Pea | Vegetables | Others | Total Zaid |
| :---: | :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Takipur | 37.98 | 0.00 | 4.35 | 2.44 | 0.95 | 0.00 | 0.47 | 0.90 | 4.61 |
| 2. | Hetalpur | 39.75 | 0.05 | 4.61 | 1.64 | 0.04 | 0.34 | 0.00 | 0.73 | 4.83 |
| 3. | Elampura | 23.09 | 4.65 | 13.05 | 3.00 | 0.00 | 0.00 | 0.68 | 0.83 | 3.10 |
| 4. | Markhi | 32.87 | 2.05 | 6.62 | 0.00 | 2.14 | 0.00 | 0.00 | 2.30 | 4.00 |
| 5. | Ainchana | 21.95 | 0.00 | 0.74 | 22.37 | 0.00 | 0.00 | 0.00 | 1.53 | 6.32 |
| 6. | Kasison | 37.17 | 1.08 | 3.54 | 4.82 | 0.00 | 0.00 | 0.00 | 1.93 | 2.91 |
| 7. | Tejpur | 38.34 | 2.57 | 5.33 | 0.00 | 0.00 | 0.00 | 0.00 | 1.84 | 3.85 |
| 8. | Faridpur | 31.91 | 1.39 | 7.84 | 0.82 | 3.11 | 0.00 | 0.00 | 3.31 | 2.92 |
| 9. | Luosara Bisawan | 25.29 | 3.74 | 2.99 | 4.93 | 0.00 | 0.00 | 8.22 | 2.68 | 4.31 |
| 10. | Kaithwari | 20.66 | 1.21 | 3.99 | 16.69 | 1.95 | 0.00 | 3.15 | 1.27 | 2.94 |
| 11. | Boner | 26.88 | 0.00 | 5.87 | 4.97 | 3.20 | 2.85 | 2.01 | 2.76 | 2.91 |
| 12. | Pikhlauni | 21.90 | 0.00 | 5.21 | 3.05 | 0.38 | 2.31 | 12.66 | 0.81 | 7.35 |
| 13. | Bistauli | 40.41 | 0.00 | 0.00 | 1.96 | 1.44 | 0.00 | 0.00 | 1.52 | 6.77 |
| 14. | Khurrampur | 41.27 | 0.00 | 0.00 | 1.39 | 1.85 | 0.00 | 0.00 | 2.33 | 6.33 |
| 15. | Pilkhuni | 10.30 | 2.99 | 0.00 | 1.74 | 0.00 | 0.00 | 25.72 | 3.50 | 11.50 |
| 16. | Govali | 34.83 | 4.66 | 2.84 | 0.95 | 0.35 | 0.00 | 0.00 | 2.33 | 8.10 |
| 17. | Taraichi | 35.30 | 4.16 | 1.05 | 0.00 | 0.00 | 0.00 | 2.63 | 3.50 | 6.69 |
| 18. | Alipur | 37.37 | 5.07 | 0.58 | 0.00 | 0.00 | 0.00 | 0.00 | 4.37 | 5.21 |
| 19. | Makhdum Nagar | 36.61 | 2.21 | 2.03 | 0.00 | 1.88 | 0.00 | 1.27 | 3.18 | 5.66 |
| 20. | Rahmapur | 34.01 | 3.55 | 0.26 | 7.62 | 0.00 | 0.00 | 0.89 | 1.98 | 3.38 |
| 21. | Ektajpur | 25.61 | 0.42 | 0.57 | 17.82 | 0.00 | 0.00 | 1.69 | 1.50 | 4.79 |
| 22. | Gidaura | 20.13 | 0.13 | 0.65 | 25.46 | 0.00 | 0.00 | 0.00 | 1.67 | 3.91 |
| 23. | Taharpur | 14.23 | 0.64 | 0.45 | 26.47 | 0.00 | 0.00 | 2.87 | 1.28 | 8.10 |
| 24. | Kaimawali | 17.77 | 2.08 | 5.10 | 20.17 | 0.00 | 0.00 | 0.00 | 1.86 | 6.04 |
|  | Total | $\mathbf{2 9 . 8 7}$ | $\mathbf{1 . 4 9}$ | $\mathbf{3 . 2 2}$ | 7.54 | $\mathbf{0 . 6 7}$ | $\mathbf{0 . 2 4}$ | $\mathbf{2 . 1 5}$ | $\mathbf{1 . 8 8}$ | 5.21 |
| Sour | Bar |  |  |  |  |  |  |  |  |  |

Sources: Based on data obtained from field survey, 2016

In these three villages the reason for lowest share of wheat crop is due to high share of potato.

## Barley

In the case of limited resources of fertilizers and irrigation, the cultivation of barley is more beneficial than wheat. Barley contributes only 1.49 percent to total cropped area. Alipur shares 5.07 percent followed by Govali ( 4.66 percent), Elampura (4.65 percent), and Tarainchi (4.16 percent) area under barley. There are seven villages, namely, Markhi, Tejpur, Luosara Bisawan, Pilkhuni, Makhdum Nagar, Rahmapur and Kaimawali which share between 2-4 percent area under barley whereas six villages, namely, Kasison, Faridpur, Kaithwari, Ektajpur, Gidaura and Taharpur record below 2 percent area under barley. There is no area under barley in Takipur, Ainchana, boner, Pikhlauni, Bistauli, and Khurrampur. The yield of barley is low so farmers are not interested in barley.

## Potato

Potato is second Rabi crop in Aligarh district. The total area under potato cover 229.42 hectare out of 3042.88 hectare gross cropped area. It shares 7.54 percent to gross cropped area. It is seen from the table 7.5 that the area under potato is high in Taharpur (26.47 percent), followed by Gidaura ( 25.46 percent), Ainchana ( 22.37 percent), Kaimawali (20.17 percent), Ektajpur (17.82 percent) and Kaithwari (16.69 percent).

The reason for high area under potato is availability of cold storage near the villages and soil is also suitable for potato cultivation. No area under potato has been found in Markhi, Tejpur, Taraichi, Alipur and Makhdum Nagar whereas remaining villages have been recorded low area under potato.

## Mustard

Mustard is third rank Rabi crop in study region and is main oilseeds crops. After a number of attempts in study region, the area under mustard is not increasing. The main


Figure 7.7


Plate 20.
Wheat Harvesting


Plate 22.
Mustard
Cultivation


Plate 23.
Cauliflower
Cultivation

Plate 24.
Cabbage Cultivation


Plate 25.
Green Chilly Cultivation


Plate 26.
Masur Cultivation

Plate 27.
Ginger Cultivation


Plate 28.
Pea Cultivation
reason is that due to increase in irrigation efficiency, increase in area under other important crops. Its cultivation is more beneficial at the condition of limited irrigation. It covers 3.22 percent area to Gross Cropped area. The highest area under mustard has been recorded in Elampura and Faridpur i.e. 13.05 percent and 7.84 percent respectively. The area under mustard between 5-7 percent has been registered in five villages namely, Markhi ( 6.62 percent), Tejpur ( 5.33 percent), Boner ( 5.87 percent), Pikhlauni (5.21 percent) and Kaimawali ( 5.10 percent). The lowest area under mustard have been seen in Rahmapur ( 0.26 percent), Taharpur ( 0.45 percent), Ektajpur ( 0.57 percent), Alipur (0.58 percent), Gidaura ( 0.65 percent), and Ainchana ( 0.74 percent). There are three villages namely Bistauli, Khurrampur and Pilkhuni which record no area under mustard.

## Pulses

The main Rabi pulses are Masur, Pea and Gram. In selected villages, the area under gram is not found in any villages while peas also share negligible percentage. It has been found only in Boner and Pikhlauni i.e. 2.85 percent and 2.26 percent respectively. Masur is dominant pulse in pulses of Rabi season while Moong is dominat in Kharif and Zaid season. Masur shares only 0.67 percent to gross cropped area. The highest percentage area under masur has been recorded in Boner village among all selected villages by 3.20 percent. There are two villages namely, Faridpur and Markhi which cover 3.11 percent and 2.14 percent respectively whereas Takipur, Hetalpur, Kaithwari, Pikhlauni, Bistauli, Khurrampur, Govali and Makhdum Nagar share area under masur below 2 percent. There is no area under masur in eleven villages i.e. Elampura, Ainchana, Kasison, Tejpur, Luosara Bisawan, Alipur, Rahmapur, Ektajpur, Gidaura, Taharpur and Kaimawali. The reasons for low share of pulse are low yield, susceptible to diseases, not available of High Yielding Varieties of Seeds and harm by wild animals (antelope and wild pig).

## Vegetables

Peas, Onion, Garlic, Radish, Carrot and Cauliflower are main vegetables of Rabi season. Table 7.5 shows that two villages, namely Pilkhuni and Pikhlauni share highest area under vegetation i.e. 25.72 percent and 12.66 percent respectively. Luosara Bisawan
covers 8.22 percent area under vegetables. There are only nine villages (Takipur, Elampura, Kaithwari, and boner, Taraichi, Makhdum Nagar, Rahmapur, Ektajpur and Taharpur) which record below 3 percent while rests of 12 villages have no area under vegetation (Table 7.5)

## Others

Others include fodder, Sesbania Bispinosa (local name Dhaincha), sweet potato, water melon, melon and cucumber. Sesbania Bispinosa and sweet potato have been observed in Gidaura, Taharpur, and Kaimawali.

## Zaid Crops

Maize, Millet, Moong and Vegetables are important crops in zaid season. Millet and Moong are prominent zaid crop in all villages. Millet covers large area in Atrouli tehsil and it cultivates at a large scale. The highest area under zaid has been recorded in Pilkhuni (11.50 percent) because of vegetables and moong cultivation. After Pilkhuni, Govali shares 8.10 percent due to high area under millet. Pikhlauni shares 7.35 percent due to vegetables while Taraichi records 6.69 percent area due to high maize and millet area. Other villages have more millet area than maize area.

### 7.6 Area, Production and Yield of Major Crops

Table 7.6 shows the area, production and yield of different crops.

Wheat - Wheat is prominent crop in all villages. It is the main dietary habit of inhabitants of Aligarh. Therefore, every farmer grows wheat for their survival. It is mentioned that during the time of field survey, the crop of wheat is loss due to hailstorm and heavy rainfall. The farmers also died from shock after seeing the heavy damage of crops by intense rains and hailstorms. Deputy agriculture director, Rohtash Kumar said, "Chandaus, adjoining Jawan block and parts of Atrouli have suffered the heaviest crop loss, with wheat crop getting completely flattened. The same situation has also been observed in Khair and Gabhana. We are conducting a survey of losses in different areas of the district. Potato and some other crops have been saved." So after this disturbance of

Table 7.6: Area, Production and Yield of different Crops in Selected Villages of Aligarh District

| $\mathrm{S}$No. | VILLAGES | WHEAT |  |  | RICE |  |  | MILLET |  |  | MAIZE |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Area | Production | Yield | Area | Production | Yield | Area | Production | Yield | Area | Production | Yield |
| 1. | Takipur | 64.24 | 2409.00 | 37.50 | 66.44 | 2908.74 | 43.78 | 8.72 | 218.00 | 25.00 | 0.40 | 9.82 | 24.56 |
| 2. | Hetalpur | 73.84 | 2868.68 | 38.85 | 52.86 | 2419.93 | 45.78 | 22.72 | 681.60 | 30.00 | 0.00 | 0.00 | 0.00 |
| 3. | Elampura | 31.36 | 1293.60 | 41.25 | 22.44 | 981.75 | 43.75 | 13.48 | 417.88 | 31.00 | 0.40 | 9.60 | 24.00 |
| 4. | Markhi | 29.44 | 1177.60 | 40.00 | 28.83 | 1370.87 | 47.55 | 1.12 | 42.00 | 37.50 | 0.00 | 0.00 | 0.00 |
| 5. | Ainchana | 35.56 | 1697.99 | 47.75 | 69.12 | 3618.43 | 52.35 | 0.00 | 0.00 | 0.00 | 0.80 | 0.00 | 0.00 |
| 6. | Kasison | 66.28 | 2734.05 | 41.25 | 34.24 | 1544.91 | 45.12 | 44.88 | 1716.66 | 38.25 | 0.00 | 0.00 | 0.00 |
| 7. | Tejpur | 34.96 | 1082.01 | 30.95 | 23.36 | 1144.64 | 49.00 | 8.12 | 223.71 | 27.55 | 1.92 | 66.24 | 34.50 |
| 8. | Faridpur | 31.24 | 943.76 | 30.21 | 7.72 | 353.19 | 45.75 | 24.48 | 654.84 | 26.75 | 5.12 | 181.25 | 35.40 |
| 9. | Luosara Bisawan | 23.00 | 1081.00 | 47.00 | 0.32 | 12.99 | 40.60 | 31.04 | 931.20 | 30.00 | 0.00 | 0.00 | 0.00 |
| 10. | Kaithwari | 26.74 | 1159.45 | 43.36 | 14.06 | 579.69 | 41.23 | 35.58 | 1115.43 | 31.35 | 0.00 | 0.00 | 0.00 |
| 11. | Boner | 24.90 | 1052.03 | 42.25 | 20.96 | 910.71 | 43.45 | 13.40 | 399.99 | 29.85 | 0.40 | 10.10 | 25.25 |
| 12. | Pikhlauni | 36.80 | 1481.20 | 40.25 | 21.92 | 971.28 | 44.31 | 22.12 | 680.19 | 30.75 | 2.88 | 87.12 | 30.25 |
| 13. | Bistauli | 70.94 | 3440.59 | 48.50 | 72.72 | 3583.64 | 49.28 | 0.00 | 0.00 | 0.00 | 2.64 | 85.93 | 32.55 |
| 14. | Khurrampur | 57.10 | 2740.80 | 48.00 | 53.96 | 2603.57 | 48.25 | 4.75 | 117.56 | 24.75 | 0.00 | 0.00 | 0.00 |
| 15. | Pilkhuni | 7.30 | 328.50 | 45.00 | 8.77 | 423.42 | 48.28 | 2.00 | 50.00 | 25.00 | 3.20 | 160.00 | 50.00 |
| 16. | Govali | 44.20 | 1889.55 | 42.75 | 34.29 | 1714.50 | 50.00 | 2.61 | 97.88 | 37.50 | 8.60 | 559.00 | 65.00 |
| 17. | Taraichi | 26.80 | 917.90 | 34.25 | 8.48 | 340.22 | 40.12 | 15.52 | 589.76 | 38.00 | 6.20 | 341.00 | 55.00 |
| 18. | Alipur | 31.10 | 1041.85 | 33.50 | 23.18 | 1002.07 | 43.23 | 2.40 | 76.80 | 32.00 | 6.64 | 332.00 | 50.00 |
| 19. | Makhdum Nagar | 40.48 | 1315.60 | 32.50 | 12.20 | 463.60 | 38.00 | 28.96 | 868.80 | 30.00 | 6.70 | 375.20 | 56.00 |
| 20. | Rahmapur | 42.13 | 1579.88 | 37.50 | 33.23 | 1453.81 | 43.75 | 13.92 | 609.00 | 43.75 | 4.04 | 202.00 | 50.00 |
| 21. | Ektajpur | 47.08 | 2095.06 | 44.50 | 55.98 | 2734.62 | 48.85 | 4.86 | 138.75 | 28.55 | 5.34 | 214.83 | 40.23 |
| 22. | Gidaura | 24.60 | 940.95 | 38.25 | 34.04 | 1505.59 | 44.23 | 17.44 | 521.28 | 29.89 | 0.00 | 0.00 | 0.00 |
| 23. | Taharpur | 15.96 | 626.91 | 39.28 | 14.44 | 739.76 | 51.23 | 25.64 | 790.99 | 30.85 | 0.00 | 0.00 | 0.00 |
| 24. | Kaimawali | 22.88 | 925.50 | 40.45 | 30.28 | 1476.15 | 48.75 | 11.34 | 312.42 | 27.55 | 2.24 | 72.80 | 32.50 |

Contin...

| $\begin{gathered} \hline \text { S. } \\ \text { No. } \end{gathered}$ | VILLAGES | MUSTURAD |  |  | POTATO |  |  | PULSES |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Area | Production | Yield | Area | Production | Yield | Area | Production | Yield |
| 1. | Takipur | 7.36 | 165.60 | 22.50 | 4.12 | 1030.00 | 250.00 | 1.60 | 18.40 | 11.5 |
| 2. | Hetalpur | 8.56 | 207.58 | 24.25 | 3.04 | 851.20 | 280.00 | 6.64 | 83.00 | 12.50 |
| 3. | Elampura | 17.72 | 252.51 | 14.25 | 4.07 | 895.40 | 220.00 | 11.60 | 145.00 | 12.50 |
| 4. | Markhi | 5.93 | 148.25 | 25.00 | 0.00 | 0.00 | 0.00 | 5.12 | 64.00 | 12.5 |
| 5. | Ainchana | 1.20 | 32.58 | 27.15 | 36.24 | 14496.00 | 400.00 | 1.72 | 19.78 | 11.50 |
| 6. | Kasison | 6.32 | 162.74 | 25.75 | 8.60 | 1892.00 | 220.00 | 1.28 | 12.80 | 10.00 |
| 7. | Tejpur | 4.86 | 140.94 | 29.00 | 0.00 | 0.00 | 0.00 | 1.20 | 13.20 | 11.00 |
| 8. | Faridpur | 7.68 | 207.36 | 27.00 | 0.80 | 160.00 | 200.00 | 8.80 | 101.20 | 11.50 |
| 9. | Luosara Bisawan | 2.72 | 34.00 | 12.50 | 4.48 | 1344.00 | 300.00 | 0.40 | 5.20 | 13.00 |
| 10. | Kaithwari | 5.17 | 69.80 | 13.50 | 21.60 | 8208.00 | 380.00 | 8.28 | 105.98 | 12.80 |
| 11. | Boner | 5.44 | 78.88 | 14.50 | 4.60 | 1150.00 | 250.00 | 10.94 | 153.16 | 14.00 |
| 12. | Pikhlauni | 8.76 | 155.49 | 17.75 | 5.12 | 1536.00 | 300.00 | 9.76 | 131.76 | 13.50 |
| 13. | Bistauli | 0.00 | 0.00 | 0.00 | 3.44 | 730.83 | 212.45 | 2.52 | 27.72 | 11.00 |
| 14. | Khurrampur | 0.00 | 0.00 | 0.00 | 1.92 | 380.16 | 198.00 | 4.80 | 57.60 | 12.00 |
| 15. | Pilkhuni | 0.00 | 0.00 | 0.00 | 1.23 | 266.75 | 216.87 | 0.00 | 0.00 | 0.00 |
| 16. | Govali | 3.60 | 36.00 | 10.00 | 1.20 | 246.00 | 205.00 | 10.45 | 130.63 | 12.5 |
| 17. | Taraichi | 0.80 | 9.60 | 12.00 | 0.00 | 0.00 | 0.00 | 0.18 | 1.44 | 8.00 |
| 18. | Alipur | 0.48 | 4.80 | 10.00 | 0.00 | 0.00 | 0.00 | 2.80 | 28.00 | 10.00 |
| 19. | Makhdum Nagar | 2.24 | 22.40 | 10.00 | 0.00 | 0.00 | 0.00 | 2.48 | 22.32 | 9.00 |
| 20. | Rahmapur | 0.32 | 3.20 | 10.00 | 9.44 | 1935.20 | 205.00 | 3.12 | 32.76 | 10.50 |
| 21. | Ektajpur | 1.04 | 15.08 | 14.50 | 32.76 | 12776.40 | 390.00 | 16.94 | 223.61 | 13.20 |
| 22. | Gidaura | 0.80 | 10.00 | 12.50 | 31.12 | 11514.40 | 370.00 | 3.56 | 37.38 | 10.50 |
| 23. | Taharpur | 0.50 | 12.13 | 24.25 | 29.68 | 11278.40 | 380.00 | 4.38 | 50.37 | 11.50 |
| 24. | Kaimawali | 6.56 | 167.28 | 25.50 | 25.96 | 9735.00 | 375.00 | 7.42 | 92.75 | 12.50 |

Sources: Based on data obtained from field survey, 2016
Area in hectares, production in quintals, yield in quintal/hectare
climate, the highest yield has been found in Bistauli (48.50 quintal/ha) and Khurrampur (48 quintal/ha) due to use of advanced agricultural implements, high irrigation and high use of fertilizers. The lowest yield has been registered in Tejpur ( 30.95 quintal/ha), Faridpur (30.21 quintal/ha), Makhdum Nagar (32.50 quintal/ha), Alipur (33.50 quintal/ha), Taraichi ( 34.25 quintal/ha). There are four villages namely, Elampura, Kasison, Pikhlauni and Taharpur which have average yield i.e. 41.00 quintal/ha. The rate of wheat is stagnant during last years. The government rate of wheat is 1525 Rs. per quintal in 2016 while its rate was 1450 Rs. per quintal in 2015.

It is seen from the table 7.6 that the production of wheat is high in Takipur, Hetalpur, Kasison, Bistauli, Khurrampur, and Ektajpur. These villages are high in production due to good irrigation, use of HYV seeds and modern agricultural techniques. The medium level of wheat production has been observed in Elampura, Markhi, Ainchana, Kaithwari, Pikhlauni, Govali, Makhdum Nagar, and Rahmapur whereas low production has been noticed in remaining ten villages.

Rice - Rice is the second major crop after wheat. The yield of rice depends on the variety seed of rice. The Peetal variety gives 37.50 quintal/ha yields while Sugandh give yield as 50 quintal/ha. The highest yield has been recorded in Ainchana ( 52.35 quintal/ha) followed by Taharpur ( 51.23 quintal/ha) and Govali (50 quintal/ha) while the production is also highest in Ainchana (3618.43 quintals) followed by Bistauli (3583.64 quintals). It has been found that the high yield of rice is due to high irrigation but in Bistauli, irrigation facilities are good but yield is becoming low because of continuous practice of rice last many years. On the other hand, yield has increased in Markhi and Tejpur (47.55 quintal/ha and 49 quintal/ha) while the production is low in these villages due to low area. Although irrigation facilities and use of fertilizers in these villages are not good as compared to other villages but yield is high due to crop rotation. In these villages, the farmers were focused to millet but due to good price of rice, the farmers are to be paying attention for rice now days instead of millet. The lowest yield has been found in Makhdum Nagar, Taraichi, and Luosara Bisawan due to low irrigation facilities. The fact is that where canal irrigation is not available, the yield of rice is low. The demand of


Figure 7.8


Figure 7.9
water in rice is high; the small farmers can not fill the requirement of water by hired tubewells and also own tube-wells.

The high production of rice has been found in Takipur, Hetalpur, Bistauli, Khurrampur, and Ektajpur. These villages are high in rice in Kharif season while it is high in wheat in rabi season because of good agricultural practices in these villages. The medium level of production of rice has been observed in nine villages, namely Elampura, Markhi, Kasison, Tejpur, Pikhlauni, Govali, Alipur, Rahmapur, and Kaimawali whereas low production has been noticed in eight villages i.e. Faridpur, Luosara Bisawan, Kaithwari, Boner, Pilkhuni, Taraichi, Makhdum Nagar, and Taharpur.

Millet - It is main coarse cereal crop. Except two villages namely, Ainchana and Bistauli, every village has area under millet in Rabi season. In these villages, large farmers have attractive for rice because of easy convenience of waters. The highest yield has been recorded in Rahmapur ( 43.75 quintal/ha). The reason is that 100 percent farmers use hybrid seed of millet. Table 7.6 indicates that there are Markhi, Kasison, Govali, Taraichi which record yield between 37-38 quintal/ha whereas ten villages namely, Hetalpur, Elampura, Luosara Bisawan, Kaithwari, Pikhlauni, Alipur, Makhdum Nagar, Gidaura, Taharpur and Boner record around 30 quintal/ha yield of millet. The soil is suitable for millet cultivation in these areas. The lowest yield has been found in Takipur, Tejpur, Faridpur, Khurrampur, Pilkhuni, Ektajpur, and Kaimawali.

The high production of millet has been registered in seven villages, namely, Hetalpur, Kasison, Luosara Bisawan, Kaithwari, Pikhlauni, Makhdum Nagar, and Taharpur. Out of these seven villages, the highest production of millet has been found in Kasison. Table 7.6 shows that medium level of millet production has been noticed in seven villages i.e. Elampura, Faridpur, boner, Taraichi, Rahmapur, Gidaura and Kaimawali. The low production of millet has been found in eight villages, namely, Takipur, Markhi, Tejpur, Khurrampur, Pilkhuni, Govali, Alipur and Ektajpur.

Maize- The high yield and production is confined in villages of eastern part of the district. Table 7.6 shows that there are six villages, namely, Govali, Taraichi, Alipur, Makhdum Nagar, Rahmapur, and Ektajpur which have high yield and high production.


Figure 7.10


Figure 7.11


Figure 7.12

The production has been recorded high in these villages because of use of modern technology like line sowing seeds, use of hybrid seeds and timely sowing. The yield and production have been registered medium in Tejpur, Faridpur, Pikhlauni, Bistauli, Pilkhuni, and Kaimawali. The low yield and production of maize have been marked in three villages i.e. Takipur, Elampura, and Boner. No maize cultivation has been found in nine villages, namely, Hetalpur, Markhi, Ainchana, Kasison, Luosara Bisawan, Kaithwari, Khurrampur, Taharpur, and Kaimawali. The yield of maize is low due to destruction of maize crops by antelopes.

Mustard- The highest yield of mustard has been found in Tejpur (29 quintal/ha). The lowest yield of mustard has been recorded in Govali, Taraichi, Alipur, Makhdum Nagar, Rahmapur and Gidaura range between 10-12 quintal/ha. Between 20-30 quintal/ha yield has been found in Elampura, Markhi, Ainchana, Kasison, Tejpur, Faridpur and Taharpur and Kaimawali.

The high production of mustard has been noticed in nine villages, namely, Takipur, Hetalpur, Elampura, Markhi, Kasison, Tejpur, Faridpur, Pikhlauni and Kaimawali. The low production of mustard has been registered in ten villages, namely Ainchana, Luosara Bisawan, Govali, Taraichi, Alipur, Makhdum Nagar, Rahmapur, Ektajpur, Gidaura and Taharpur. During survey, no cultivation of mustard has been found in Bistauli, Khurrampur and Pilkhuni.

Potato- The yield of potato varies from 180-400 quintal/ha. Table 7.6 indicates that yield and production of potato is highest in Ainchana ( 400 quintal/ha and 14496 quintals) followed by Ektajpur ( 390 quintal/ha and 12776 quintals). The yield is also high in Gidaura, Taharpur, Kaimawali and Kaithwari (above 370 quintal/ha). The reason is that there are available of a large no. of cold storages in Iglas block and soil ph. is also suitable for potato cultivation. The medium quality of soil is found in Iglas and Gonda block in which the nitrogen is available as $5 \mathrm{~kg} / \mathrm{ha}$, phosphorous as $25 \mathrm{~kg} / \mathrm{ha}$ and potash as $220 \mathrm{~kg} / \mathrm{ha}$. In these villages, agricultural implements and irrigation are also good. The lowest yield of potato has been seen in Khurrampur (198 quintal/ha), Govali (205 quintal/ha), Bistauli ( 212.45 quintal/ha) due to unsuitable soil condition and not available


Figure 7.13


Figure 7.14
of cold storages. Where cold storage is not available, farmers are not cultivated potato. But it is evergreen crop; the farmers have started cultivate of potato crops in all types of field. Either it is suitable for cultivation or not. The price of potato has been doubled in recent two years. The rate of potato is an average about 800 Rs. per quintal in 2016 while it was only 400 Rs. per quintal in 2013. The farmers are paid more attention for potato cultivation. The seed potato planter is also available so the cultivation of potato is easier.

Pulses - The yield of pulses is low due to loss by wild animals and not available HYV seeds and no advance technology. It is found that no farmers want to cultivate pulses due to low profit. It is seen that due to scarcity of pulses, the price of pulses has increased from $40-60 \mathrm{Rs}$. $/ \mathrm{kg}$ to $80-140 \mathrm{Rs}$. $/ \mathrm{kg}$ within recent three years. The average yield of pulses range between 10 and 12 quintal/ha. The high yield has been seen in Boner (14 quintal/ha), Pikhlauni (13.50 quintal/ha), Ektajpur (13.20 quintal/ha), Luosara Bisawan (13 quintal/ha), and Kaithwari (12.80 quintal/ha). There are two villages, namely Taraichi and Makhdum Nagar which record 8 quintal/ha and 9 quintal/ha yield of pulses. Other villages have average yield. There is no area under pulses in Pilkhuni. Moong is also used as fertilizer. The farmers plough the moong in their field using as fertilizer for next crops.

### 7.7 Use of Agricultural Implements

In the field of agriculture, the farmers are moving gradually towards the adoption of innovation of agriculture. Efforts have been made to increase the productivity through application of technology and new innovation. Black (1945) has stated that "the process of innovation is particularly interesting to observe in agriculture because of its gradualness."

Table 7.7 shows that about 99 percent farming is done by tractors. Wooden plough is almost finished in every village because of requiring more labour. It is evident from the table 7.7 that 38.93 percent of respondents have their own tractors, with 35.26 percent harrows, 37.48 percent cultivators, 22.02 percent thrashers, 3.93 rotavators, 38.79 percent tillers, 53.74 sprayers, and 26.74 percent sowing machines. Farm implements and machinery increase resource use efficiency and productivity.

Table 7.7
Use of Agricultural Implements by Farmers in Sampled Villages of Aligarh District, 2016

| S. <br> No. | Villages | Tractors | Harrows | Cultivators | Thrashers | Rotavators | Tillers | Sprayers | Sowing Machines | Wooden Ploughs |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1. | Takipur | 63.89 | 55.56 | 63.89 | 33.33 | 5.56 | 63.89 | 75.00 | 25.00 | 0.00 |
| 2. | Hetalpur | 72.97 | 43.24 | 72.97 | 10.81 | 8.11 | 72.97 | 78.38 | 32.43 | 0.00 |
| 3. | Elampura | 22.86 | 17.14 | 22.86 | 8.57 | 0.00 | 17.14 | 20.00 | 11.43 | 2.86 |
| 4. | Markhi | 29.17 | 29.17 | 25.00 | 20.83 | 0.00 | 29.17 | 37.50 | 12.50 | 4.17 |
| 5. | Ainchana | 56.76 | 48.65 | 56.76 | 43.24 | 8.11 | 56.76 | 64.86 | 54.05 | 5.41 |
| 6. | Kasison | 45.95 | 40.54 | 45.95 | 32.43 | 2.70 | 45.95 | 86.49 | 27.03 | 0.00 |
| 7. | Tejpur | 20.00 | 20.00 | 20.00 | 16.67 | 3.33 | 20.00 | 23.33 | 3.33 | 3.33 |
| 8. | Faridpur | 18.75 | 18.75 | 18.75 | 9.38 | 0.00 | 18.75 | 25.00 | 0.00 | 0.00 |
| 9. | Luosara Bisawan | 17.24 | 17.24 | 17.24 | 10.34 | 0.00 | 17.24 | 17.24 | 10.34 | 0.00 |
| 10. | Kaithwari | 32.14 | 32.14 | 28.57 | 14.29 | 3.57 | 32.14 | 46.43 | 14.29 | 0.00 |
| 11. | Boner | 25.81 | 25.81 | 25.81 | 9.68 | 3.23 | 25.81 | 41.94 | 3.23 | 0.00 |
| 12. | Pikhlauni | 43.75 | 43.75 | 34.38 | 15.63 | 3.13 | 46.88 | 68.75 | 0.00 | 6.25 |
| 13. | Bistauli | 81.08 | 70.27 | 70.27 | 56.76 | 8.11 | 81.08 | 37.84 | 27.03 | 0.00 |
| 14. | Khurrampur | 67.65 | 67.65 | 67.65 | 52.94 | 5.88 | 67.65 | 35.29 | 35.29 | 0.00 |
| 15. | Pilkhuni | 25.93 | 22.22 | 25.93 | 7.41 | 3.70 | 25.93 | 92.59 | 33.33 | 0.00 |
| 16. | Govali | 48.28 | 48.28 | 48.28 | 44.83 | 13.79 | 48.28 | 100.00 | 62.07 | 0.00 |
| 17. | Taraichi | 21.212 | 21.212 | 21.212 | 12.121 | 3.030 | 21.212 | 48.485 | 36.364 | 0.000 |
| 18. | Alipur | 18.18 | 18.18 | 18.18 | 9.09 | 0.00 | 18.18 | 36.36 | 27.27 | 0.00 |
| 19. | Makhdum Nagar | 14.29 | 14.29 | 14.29 | 10.71 | 0.00 | 14.29 | 28.57 | 14.29 | 3.57 |
| 20. | Rahmapur | 19.35 | 19.35 | 19.35 | 9.68 | 0.00 | 19.35 | 32.26 | 19.35 | 0.00 |
| 21. | Ektajpur | 27.27 | 27.27 | 27.27 | 3.03 | 3.03 | 27.27 | 84.85 | 42.42 | 0.00 |
| 22. | Gidaura | 17.14 | 17.14 | 17.14 | 2.86 | 0.00 | 17.14 | 54.29 | 22.86 | 0.00 |
| 23. | Taharpur | 64.29 | 64.29 | 64.29 | 50.00 | 10.71 | 64.29 | 100.00 | 82.14 | 0.00 |
| 24. | Kaimawali | 59.26 | 51.85 | 51.85 | 37.04 | 7.41 | 59.26 | 96.30 | 37.04 | 0.00 |
|  | Total | 38.93 | 35.26 | 37.48 | 22.02 | 3.93 | 38.79 | 53.74 | 26.47 | 1.05 |

Sources: Based on data obtained from field survey, 2016


Figure 7.15

Tractor is powerful implement of agriculture which makes farming easier and time consuming. It plays an important role in transforming the tradition method of agriculture. About 99 percent farming is done with the help of it. It is multipurpose machinery for different farm operations. Those farmers who have tractors, all of them have harrow and cultivators. Nearly 81 percent respondents of Bistauli village have their own tractors while about 73 percent farmers in Hetalpur have their own tractors. Other than, Khurrampur, Taharpur, Takipur, Kaimawali and Ainchana use their own tractors as 67.65 percent, 64.29 percent, 63.89 percent, 59.26 percent and 56.76 percent respectively. Numbers of harrows, cultivators, thrashers, tillers are high in these villages as sequence of tractors. There are other three villages namely, Govali, Kasison and Pikhlauni which use 48.28 percent, 45.95 percent, 43.75 percent tractors respectively. These villages have high in agricultural implements due to large and marginal farmers. The percentage of own tractors are low in Makhdum Nagar (14.29 percent), Gidaura (17.14 percent), Luosara Bisawan (17.24 percent), Alipur (18.18 percent), Faridpur (18.75 percent), Rahmapur (19.35 percent) and Tejpur (20 percent). The cultivators, harrows, thrashers and tillers are also low in these villages. There are seven villages (Elampura, Markhi, Kaithwari, Boner, Pilkhuni, Taraichi and Ektajpur), have only own tractors, harrows, cultivators and tillers between 20-32 percent.

A very few rotavators are found in Aligarh district. It is new agricultural implement and distribute slowly in villages. Govali village ranks first in using rotavators with 13.79 percent followed by Taharpur ( 10.71 percent). There are 8.11 percent farmers of Hetalpur, Ainchana and Bistauli who use rotavators. The farmers of Taharpur use 100 percent sprayer and Kaimawali also use 96.30 percent sprayers because dominance of potato cash crop.

On other hand, 100 percent farmers of Govali and Taharpur use sprayers followed by Pilkhuni ( 92.59 percent), Ektajpur ( 84.85 percent), Hetalpur ( 78.38 percent) and Takipur ( 75.00 percent). The low use of sprayers by farmers has been found in Luosara Bisawan (17.24 percent) and Elampura (20.00 percent). The highest percentage of farmers using seed sowing machines has been found in Taharpur ( 82.14 percent), followed by Govali (62.07 percent) and Ainchana (54.05 percent). Between 30-40


Plate 29.
Tractor with
Rotavator

Plate 30.
Potato Planter


Plate 31.
Sowing of Potato
Seeds with
Potato Planter
Machine


Plate 32.
Tractor
Trolley

Plate 33.
Thrasher


Plate 34.
Harrow


Plate 35.
Cultivator

Plate 36.
Use of spraying in Vegetable
field


Plate 37.
Transport of Millet Crop by
Bullock Cart
percent farmers of four villages i.e. Hetalpur, Khurrampur, Pilkhuni, and Taraichi have sowing machines. Between 10-20 percent farmers using sowing machines have been found in Elampura, Markhi, Luosara Bisawan, Kaithwari, Makhdum Nagar, and Rahmapur. Only seed of wheat, potato and millet are sowing by sowing machines in Aligarh. About 3 percent famers of Boner and Tejpur have their own sowing machines. No farmer of Faridpur and Pikhlauni use sowing machines.

The wooden plough has been found in Elampura, Markhi, Ainchana, Tejpur, Pikhlauni, and Makhdum Nagar. No wooden plough is available in other villages. There are Luosara Bisawan, Elampura and Tejpur which have highest percentage of farmers (82.76 percent, 77.14 percent and 76.67 percent) who have not their own any modern agricultural implements. Contrary to this, the share of farmers having their own equipments is low in Govali ( 3.45 percent) and Kaimawali ( 3.70 percent). There is only one village i.e. Taharpur where every person has some modern agricultural implements.

### 7.8 Availability of Irrigation Sources

Irrigation is the most crucial component of agricultural development. The use of modern agricultural technology (High Yielding Varieties of seeds, fertilizers) for agricultural growth increase in crop yield and cropping intensity depends critically on irrigation. Irrigation facilities are necessary for adoption of double and multiple cropping by the farmers. Phukan (1972) and Deshpande (1986) provided statistical evidence confirming positive contribution of irrigation towards increasing cropping intensity. The rainfall is uneven distributed in a year and is usually concentrated in the summer month of July to September. Therefore, development of irrigation facilities is required. Rice and wheat require proper irrigation during whole period. Each crop also requires proper irrigation for higher yield except millet. If rainfall occurs then there is no requirement of irrigation in millet. Table 7.8 and 7.9 shows distribution of agricultural sources and area irrigated by different sources in selected villages. The total irrigated area is 2749.04 hectares of all villages which is 90.72 percent of gross cropped area. Table 7.8 reveals that private tube wells are main source of irrigation in region. It shares 35.65 percent own tube wells and 27.79 percent hired tube wells irrigate combined 56.13 percent area

Table 7.8
Number of Holdings under Different Sources of Irrigation in Selected Villages of Aligarh District, 2016
(Figures in Percent)

| S. <br> No. | Villages | Pump sets |  | Tube wells |  |  | Canal |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Own | Hired | Own | Hired | Govt. |  |
| 1. | Takipur | 80.56 | 0.00 | 5.56 | 0.00 | 0.00 | 25.00 |
| 2. | Hetalpur | 10.81 | 0.00 | 67.56 | 13.51 | 10.81 | 10.81 |
| 3. | Elampura | 5.71 | 0.00 | 34.29 | 57.14 | 8.57 | 0.00 |
| 4. | Markhi | 0.00 | 0.00 | 29.17 | 58.33 | 0.00 | 20.83 |
| 5. | Ainchana | 59.46 | 0.00 | 48.65 | 8.11 | 16.21 | 27.02 |
| 6. | Kasison | 10.81 | 0.00 | 56.76 | 24.32 | 16.21 | 0.00 |
| 7. | Tejpur | 3.33 | 0.00 | 16.67 | 80.00 | 0.00 | 3.33 |
| 8. | Faridpur | 53.13 | 15.63 | 28.13 | 9.38 | 0.00 | 0.00 |
| 9. | Luosara Bisawan | 10.34 | 10.34 | 41.38 | 31.03 | 14.81 | 0.00 |
| 10. | Kaithwari | 35.71 | 10.71 | 57.14 | 17.86 | 10.71 | 0.00 |
| 11. | Boner | 38.71 | 12.90 | 29.03 | 19.35 | 19.35 | 0.00 |
| 12. | Pikhlauni | 43.75 | 6.25 | 25.00 | 12.50 | 12.50 | 0.00 |
| 13. | Bistauli | 94.59 | 0.00 | 10.81 | 0.00 | 0.00 | 100.00 |
| 14. | Khurrampur | 54.05 | 17.65 | 21.62 | 5.88 | 18.92 | 0.00 |
| 15. | Pilkhuni | 7.41 | 3.70 | 59.26 | 29.63 | 0.00 | 0.00 |
| 16. | Govali | 31.03 | 3.45 | 48.28 | 10.34 | 13.79 | 41.38 |
| 17. | Taraichi | 0.00 | 0.00 | 27.27 | 54.55 | 18.18 | 0.00 |
| 18. | Alipur | 3.03 | 0.00 | 21.21 | 75.76 | 0.00 | 0.00 |
| 19. | Makhdum Nagar | 7.14 | 0.00 | 39.29 | 42.86 | 0.00 | 0.00 |
| 20. | Rahmapur | 19.35 | 0.00 | 29.03 | 64.52 | 0.00 | 0.00 |
| 21. | Ektajpur | 90.91 | 0.00 | 0.00 | 0.00 | 6.06 | 57.58 |
| 22. | Gidaura | 5.71 | 0.00 | 42.86 | 51.43 | 0.00 | 0.00 |
| 23. | Taharpur | 25.00 | 0.00 | 46.43 | 14.29 | 14.29 | 17.86 |
| 24. | Kaimawali | 44.44 | 0.00 | 85.18 | 0.00 | 7.41 | 62.96 |
|  | Total | 31.85 | 3.67 | 35.65 | 27.79 | 7.99 | 15.20 |

Sources: Based on data obtained from field survey, 2016

Table 7.9
Area under Different Sources of Irrigation in Selected Villages of Aligarh District, 2016
(Figures in Percent)

| S.No. | Villages | Pump sets |  | Tube wells |  |  | Canal |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Own | Hired | Own | Hired | Govt. |  |
| 1. | Takipur | 88.03 | 0.00 | 6.11 | 0.00 | 0.00 | 5.86 |
| 2. | Hetalpur | 4.55 | 0.00 | 87.18 | 4.18 | 4.09 | 0.00 |
| 3. | Elampura | 3.36 | 0.00 | 42.94 | 48.67 | 5.03 | 0.00 |
| 4. | Markhi | 0.00 | 0.00 | 46.15 | 43.77 | 0.00 | 10.08 |
| 5. | Ainchana | 43.18 | 0.00 | 44.26 | 0.66 | 1.40 | 10.50 |
| 6. | Kasison | 13.50 | 0.00 | 66.25 | 12.54 | 7.71 | 0.00 |
| 7. | Tejpur | 2.73 | 0.00 | 35.23 | 59.20 | 0.00 | 2.83 |
| 8 | Faridpur | 38.97 | 6.74 | 44.45 | 9.84 | 0.00 | 0.00 |
| 9. | Luosara Bisawan | 22.54 | 11.22 | 36.89 | 18.43 | 10.93 | 0.00 |
| 10. | Kaithwari | 29.32 | 8.41 | 45.14 | 10.93 | 6.22 | 0.00 |
| 11. | Boner | 28.83 | 9.81 | 40.24 | 12.06 | 9.07 | 0.00 |
| 12. | Pikhlauni | 58.74 | 9.98 | 19.95 | 7.35 | 3.98 | 0.00 |
| 13. | Bistauli | 47.79 | 2.11 | 10.30 | 0.00 | 0.00 | 39.80 |
| 14 | Khurrampur | 46.20 | 9.44 | 34.94 | 3.22 | 6.19 | 0.00 |
| 15. | Pilkhuni | 5.90 | 5.04 | 80.42 | 8.65 | 0.00 | 0.00 |
| 16. | Govali | 21.38 | 3.64 | 53.23 | 4.15 | 5.38 | 12.23 |
| 17. | Taraichi | 0.00 | 0.00 | 35.45 | 48.80 | 15.74 | 0.00 |
| 18 | Alipur | 6.08 | 0.00 | 22.33 | 71.59 | 0.00 | 0.00 |
| 19. | Makhdum Nagar | 9.97 | 0.00 | 55.97 | 34.06 | 0.00 | 0.00 |
| 20. | Rahmapur | 29.28 | 0.00 | 46.33 | 24.39 | 0.00 | 0.00 |
| 21. | Ektajpur | 72.50 | 0.00 | 0.00 | 0.00 | 5.03 | 22.47 |
| 22. | Gidaura | 10.94 | 0.00 | 52.77 | 36.29 | 0.00 | 0.00 |
| 23. | Taharpur | 25.97 | 0.00 | 43.91 | 12.43 | 7.21 | 10.48 |
| 24 | Kaimawali | 23.43 | 0.00 | 40.35 | 0.00 | 6.37 | 29.86 |
|  | Total | 32.59 | 2.58 | 39.62 | 15.34 | 3.79 | 6.09 |

Sources: Based on data obtained from field survey, 2016


Figure 7.16

## SOURCES OF IRRIGARION



Plate 38. Canal with low volume of water Plate 39. Canal with high volume of water


Plate 40.
Supplying Water to the Agriculture Field by Tube-well

Plate 41. Supplying Water to the Agriculture Field by Pump-set

whereas 31.85 famers have their own pump-sets (it is diesel tube well) and only 3.67 percent land holdings hired pump-sets, irrigated combine 35.17 percent area to total irrigated area. There are 7.99 farmers who take water from government tube-wells and other 15.20 percent farmers use canal water irrigated only 3.79 percent and 6.09 percent area respectively. During the field survey, it has been found that marginal and small farmers have not their own source of irrigation and they use hiring water for irrigation from private tube-wells and pump-sets. Large, medium and some semi medium farmers have their own tube-wells and pump-sets. The large and medium famers of Ainchana and Bistauli have both tube-wells and pump-sets.

The highest percentage of farmers using own pump-sets has been recorded in Bistauli ( 94.59 percent), followed by Ektajpur ( 90.91 percent) and Takipur (80.56 percent) while Takipur irrigates 88.03 percent area followed by Ektajpur ( 94.97 percent) and Bistauli ( 47.79 percent) with own pump-sets . The irrigated area with pump-sets in Bistauli is low due to famers irrigate by canals also. 100 percent farmers of Bistauli take water from canals for irrigation. The pump-sets work in those areas where water level is high. The water level is high in Bistauli and Ektajpur due to canals so in these villages, the water is supplied to fields by pump-sets. Rice and wheat are main crops in Bistauli and Takipur whereas rice and potato are prominent in Ektajpur. These crops require assured irrigation which may certain by pump-sets and canals. In Ainchana, Faridpur and Khurrampur, there are 59.46 percent, 53.13 percent and 54.05 percent farmers having their own pump-sets. The villages of Alipur, Tejpur, Gidaura, Elampura, Makhdum Nagar and Pilkhuni have low own pump-sets i.e. 3.03 percent, 3.33 percent, 5.71 percent, 5.71 percent, 7.14 percent respectively which irrigate combine 38.98 percent area. There is no pump-sets in Markhi and Taraichi.

The highest percentage of hired pump-sets has been found in Khurrampur (17.65 percent), followed by Faridpur (15.63 percent), boner (12.90 percent), Kaithwari (10.71 percent) and Luosara Bisawan (10.34 percent) which irrigate 45.62 percent area. There are three villages, namely, Govali, Pilkhuni and Pikhlauni which have low number of hired pump-sets and low irrigated area i.e. 3.45 percent, 3.70 percent and 6.25 percent hired pump-sets irrigated 3.64 percent, 5.04 percent and 9.98 percent area respectively.

The maximum number of farmers of Kaimawali use own private tube-wells i.e. 85.18 percent and there is no hired tube-well in this village. This village irrigates only 40.35 percent area by own tube-wells and no irrigation is by hired tube-wells. Because of available of canals, 62.96 percent farmers use canal water and irrigate only 29.86 percent area to total irrigated area. On the contrary, 67.56 percent farmers of Hetalpur use own tube-wells which irrigates maximum area out of 24 villages i.e. 87.18 percent area. Similarly, the farmers of Pilkhuni, Kaithwari, and Kasison ( 59.26 percent, 57.4 percent and 56.76 percent respectively) use own private tube-wells which irrigate 80.42 percent, 45.14 percent, and 66.25 percent area by own tube-wells. The low number of own private tube-wells has been found in Takipur ( 5.56 percent) and Bistauli ( 10.81 percent) which irrigate 6.11 percent and 10.30 percent area by own tube-wells. In Takipur, no one take hired water because 25 percent farmers irrigate their 5.86 percent area. There is no own tube-well found in Ektajpur, all land holders use pump-sets instead of tube-wells. There are 80 percent farmers of Tejpur which take water from hired water from tube-wells and irrigate 59.20 percent area. The villages of Elampura, Markhi, Taraichi, Alipur, Rahmapur and Gidaura having more than 50 percent take water on payment from private tube-wells. These famers are small and marginal and they can not afford for their own tube-wells. They depend upon private tube-wells. It is seen that sometimes they do not take water at right time because of irregular supply of electricity. They wait for long time because the large farmers irrigate first their land; they give water to others on their own will at higher amount. The conditions of small and marginal farmers are very poor.

The govt. tube-well is not more beneficial to the farmers. The farmers wait for watering. Due to scarcity of light, it is not useful. In every village, six to eight hours electricity comes either in day or night. There is no schedule of electricity in villages. When the dust storms blow, the light is gone for a long time. There are two villages namely, Ektajpur and Kaimawali which have lowest percentage of farmers i.e. 6.06 percent and 7.41 percent respectively who take water from govt. tube-well. There is no govt. tube-well in Takipur, Markhi, Tejpur, Faridpur, Bistauli, Pilkhuni, Alipur, Makhdum Nagar, Rahmapur and Gidaura whereas rest of villages use water from govt. tube-wells between 10-20 percent and irrigate area below 10 percent except Taraichi (14.11 percent) and Luosara Bisawan (10.93).

Canal irrigation is very cheap for irrigation rather than pump-sets irrigation. In this way, we can say that minimum input and maximum output from this source of irrigation. Canal irrigation is available in Takipur, Hetalpur, Markhi, Ainchana, Tejpur, Bistauli, Govali, Ektajpur, Taharpur and Kaimawali. Canal also passes through Rahmapur and Kaithwari but canals are dried. 100 percent farmers of Bistauli irrigate 39.80 percent area of total irrigated area. There are 7.41 percent of Kaimawali, 6.06 percent of Ektajpur and 13.79 percent farmers of Govali who irrigate 29.86 percent, 22.47 percent area and 12.23 percent area respectively. There are other six villages, namely, Takipur, Markhi, Ainchana, Tejpur and Taharpur which irrigate below 10 percent area. The canal is filled with water only in rainy season. The Upper Ganges Canal has less volume of water so one small canal build along it with high volume capacity of water. The farmers use water it from all seasons. The main problem of the farmers is that canals are dried and no one pays attention on it.

### 7.9 Application of Chemical Fertilizers, High Yielding Varieties and Bio- fertilizers

One of the most important ingredients of modern agricultural technology is chemical fertilizers. The applications of chemical fertilizers are required both proper irrigation and drainage otherwise application of fertilizer may be highly dangerous. Nagraj (1983), "Irrigation has dominant influence on the application of chemical fertilizers by farmers, although the use of HYV seeds and other fertilizer intensive crops also had positive effect on a farm's fertilizers consumption". In selected villages, the application of fertilizers was uneven between crops and between large and small farmers. It is seen that 100 percent farmers use chemical fertilizers and bio-fertilizers. It appears during survey that farmers are failed to give desired doses of chemical fertilizers to their field according to crops. But the farmers use a small amount of bio-fertilizer and unsystematic manner. They do not make bio fertilizers in systematic way; they spread their animal dung directly in field. It is found that large farmers use high consumption of fertilizers while small farmers use low consumption. High doses of fertilizers require high irrigation. The farmers use major nutrient Nitrogen, Phosphorous and Potash. Now days, farmers also use micro nutrient Zinc and Sulphur. No one farmer uses chemical fertilizer at balanced ratio of different crops. They use fertilizers their wayward. The
recommended N : P : K for rice and wheat is $120: 60: 40 \mathrm{~kg} / \mathrm{ha}$, millet $80: 40: 40$, maize 150:75:60, mustard 120:60:60, potato 150:60:40. In wheat and rice, The Urea is applied in two split doses $60 \mathrm{~kg} / \mathrm{ha}$ at the time basal dressing and the remaining $60 \mathrm{~kg} / \mathrm{ha}$ is used at the first irrigation (after 23-25 days of seed sowing) while some also use before maturing crops. While full phosphorous and potash is applied at the time basal dressing. In all selected villages, the farmers use Urea, DAP and Potash. In wheat cultivation, farmers use urea from $150 \mathrm{~kg} /$ ha to $315 \mathrm{~kg} /$ ha and DAP from $72.5 \mathrm{~kg} / \mathrm{ha}$ to $185.5 \mathrm{~kg} / \mathrm{ha}$. About 50 percent farmers use zinc and sulphur and not used potash in wheat cultivation. The farmers use Urea (180-320 kg/ha), DAP ( $90-156.5 \mathrm{~kg} / \mathrm{ha}$ ), zinc and sulphur ( $10-20 \mathrm{~kg} / \mathrm{ha}$ ) in rice cultivation. In millet, Urea is only used as ranging from $125-240 \mathrm{~kg} / \mathrm{ha}$. The range of urea and DAP is $125-187.5 \mathrm{~kg}$ / ha and $62.5-130 \mathrm{~kg} / \mathrm{ha}$ in maize. The high doses of fertilizer is used in potato where urea is used from $220-375 \mathrm{~kg} / \mathrm{ha}$, DAP $440-600 \mathrm{~kg} / \mathrm{ha}$, Potash $180-300 \mathrm{~kg} / \mathrm{ha}$. Most of the farmers use no fertilizer in pulses. The zinc and sulphur are not provided by the co-operative societies so few farmers use them. the result of selected villages that the villages of Ainchana, Bistauli, Khurrampur, Govali, Ektajpur, Gidaura, Taharpur and Kaimawali use high fertilizer consumption whereas the villages of Markhi, Kasison, Elampura, Tejpur, Faridpur, Luosara Bisawan use low fertilizer consumption.

The excessive use of chemical fertilizers imbalanced the soil nutrients. As Marothia (1997) concludes that "extensive soil testing facilities, availability of appropriate fertilizers, integrated fertilizer management through the use of judicious mix of organic manure, bio-fertilizer, green manure and chemical fertilizers for minimizing adverse environmental effects and the long term fertilizer price policy require urgent attention. More research and extension efforts are required to make these technologies commercially viable."

High Yielding Varieties of seeds depends largely on application of fertilizer in adequate quantities. Foundation and certified seeds are available in all villages. Out of all crops, the hybrid seed of millet and maize is available. It increases the production of millet and maize. The major drawback of hybrid seed is that it can not grow again. Most
of the farmers use Pusa Sughand-04, Pusa Sughand-05, Pusa Sugandh-1 HYV seed of rice and use Shatabdi for wheat.

Hardly single farmer cultivates crop by entire use of bio-fertilizer and 5 percent farmers use non-conventional bio-fertilizer like Azolla, organic trichoderma powder etc. The earthworm compost is being applied in villages of Atrouli, Lodha and Iglas.

### 7.10 Finance

Capital is essential for improving agriculture conditions. This facility is provided by credit institutions. Cooperative societies and Kisan Credit Card are two essential ways of financial support to farmers. Cooperative societies supply various services to their members with inputs for agricultural production including seeds, fertlisers and agricultural machineries. According to Omotesho (2008), "Cooperative society is one of the most effective vehicle for efficient mobilization of production resources and accelerated agricultural development." Kisan Credit Card (KCC) is a scheme which provides affordable credit to farmers. This scheme


Figure 7.17
is initiated in India during the year 1998-99 with the help of Reserve Bank of India (RBI) and National Bank for Agriculture and Rural Development (NABARD) for helping the farmers by providing timely and adequate credit. It is observed during field survey that cooperative societies are not working properly. Seeds, fertlisers and other services are not supplied by cooperative societies at time.

It is evident from the figure 7.17 that only 14.42 percent farmers use services from cooperative societies and 45.22 percent farmers use Kisan Credit Card. It is found that the farmers, who have more than 2 acre land, have Kisan Credit Card. It is also

Table 7.10
Farmers using Co-operative Societies and Kisan Credit Card (KCC) in Selected Villages of Aligarh District, 2016
(Figures in Percent)

| S. No. | Villages | Cooperative Societies | Kisan Credit Cards |
| :---: | :---: | :---: | :---: |
| 1. | Takipur | 19.44 | 52.78 |
| 2. | Hetalpur | 10.81 | 48.65 |
| 3. | Elampura | 14.29 | 48.57 |
| 4. | Markhi | 8.33 | 41.67 |
| 5. | Ainchana | 21.62 | 62.16 |
| 6. | Kasison | 13.51 | 40.54 |
| 7. | Tejpur | 10.00 | 30.00 |
| 8 | Faridpur | 12.50 | 37.50 |
| 9. | Luosara Bisawan | 13.79 | 41.38 |
| 10. | Kaithwari | 14.29 | 42.86 |
| 11. | Boner | 9.68 | 35.48 |
| 12. | Pikhlauni | 15.63 | 56.25 |
| 13. | Bistauli | 16.22 | 59.46 |
| 14 | Khurrampur | 17.65 | 55.88 |
| 15. | Pilkhuni | 11.11 | 25.93 |
| 16. | Govali | 13.79 | 51.72 |
| 17. | Taraichi | 15.15 | 27.27 |
| 18 | Alipur | 12.12 | 30.30 |
| 19. | Makhdum Nagar | 14.29 | 39.29 |
| 20. | Rahmapur | 9.68 | 41.94 |
| 21. | Ektajpur | 15.15 | 60.61 |
| 22. | Gidaura | 14.29 | 42.86 |
| 23. | Taharpur | 17.86 | 53.57 |
| 24 | Kaimawali | 22.22 | 48.15 |
|  | Total | 14.42 | 45.22 |

Sources: Based on data obtained from field survey, 2016
observed that most of the farmers do not pay crop loans at the time; therefore, Kisan Credit Card is cancelled.

It is seen from the table 7.10 that there are six villages namely, Takipur, Ainchana, Bistauli, Khurrampur, Taharpur and Kaimawali which are high in using services from cooperative societies whereas seven villages namely, Hetalpur, Markhi, Tejpur, boner, Pilkhuni, Alipur and Rahmapur which are low in using cooperative societies. On the other hand, high percentage of using Kisan Credit Card have been observed in eight villages i.e. Takipur, Ainchana, Pikhlauni, Bistauli, Khurrampur, Govali, Ektajpur and Taharpur whereas low percentage has been found in seven villages i.e. Tejpur, Faridpur, boner, Pilkhuni, Taraichi, Alipur and Makhdum Nagar. Size of land holdings, education and nearness of societies are important factors in determining these services

### 7.12 Levels of Agricultural Development

Table 7.11 shows that the range of variation of agricultural development is set out into three groups, viz. high, medium and low. The high level of agricultural development has been observed in eight villages, out of which Taharpur village has the highest agricultural development with z-score value of 0.868 .

Table 7.11
Levels of Agricultural Development in Selected Villages of Aligarh District, 2016
$\left.\begin{array}{|c|c|c|c|}\hline \text { Categories } & \text { Indices } & \begin{array}{c}\text { No. of } \\ \text { Villages }\end{array} & \text { Name of the Villages } \\ \hline \text { High } & \text { Above 0.275 } & 8 & \begin{array}{c}\text { Takipur, Hetalpur, Ainchana, Bistauli, } \\ \text { Khurrampur, Govali, Taharpur, Kaimawali }\end{array} \\ \hline \text { Medium } & -0.275 \text { to } \\ 0.275\end{array} \quad 7 \quad \begin{array}{c}\text { Kasison, Kaithwari, Boner, Pikhlauni, } \\ \text { Pilkhuni, Taraichi, Ektajpur }\end{array}\right]$

Source: Computed by Researcher on the basis of Appendix III

Table 7.12
Variables of Agricultural Development for Selected Villages of Aligarh District, (2016)

| Set of Variables | Symbol | Description of Variables |
| :---: | :---: | :---: |
| Human <br> Resource | $\mathrm{X}_{1}$ | Percentage of farmers to total population |
|  | $\mathrm{X}_{2}$ | Percentage of literates to total population |
| Technology | $\mathrm{X}_{3}$ | Number of tractors per 1000 hectares of gross cropped area |
|  | $\mathrm{X}_{4}$ | Number of harrows per 1000 hectares of gross cropped area |
|  | $\mathrm{X}_{5}$ | Number of cultivators per 1000 hectares of gross cropped area |
|  | $\mathrm{X}_{6}$ | Number of thrashers per 1000 hectares of gross cropped area |
|  | $\mathrm{X}_{7}$ | Number of rotavators per 1000 hectares of gross cropped area |
|  | $\mathrm{X}_{8}$ | Number of tillers per 1000 hectares of gross cropped area |
|  | X 9 | Number of sprayers per 1000 hectares of gross cropped area |
|  | $\mathrm{X}_{10}$ | Number of sowing machines per 1000 hectares of gross cropped area |
|  | $\mathrm{X}_{11}$ | Consumption of fertilizers in $\mathrm{kg} /$ hectares |
| Irrigation | $\mathrm{X}_{12}$ | Area irrigated by pump-sets in percent |
|  | $\mathrm{X}_{13}$ | Area irrigated by tube-wells in percent |
|  | $\mathrm{X}_{14}$ | Area irrigated by canal in percent |
|  | $\mathrm{X}_{15}$ | Gross irrigated area to gross cropped area |
| Land Holding | $\mathrm{X}_{16}$ | Area under large land holdings in percent |
|  | $\mathrm{X}_{17}$ | Area under medium land holdings in percent |
|  | $\mathrm{X}_{18}$ | Area under semi-medium land holdings in percent |
| Finance | X 19 | Percentage farmers using agricultural cooperative societies to total farmers |
|  | $\mathrm{X}_{20}$ | Percentage of farmers having Kisan Credit Cards to total farmers |



Figure 7.18

This village has the highest agricultural development due to high advance agricultural technology. Others are Ainchana (0.826), Bistauli (0.810), Kaimawali (0.764), Govali (0.696), Khurrampur (0.627), Takipur (0.455) and Hetalpur (0.301) which have high agricultural development. Bistauli and Khurrampur have large and medium farmers, high agricultural technology with good irrigation facilities. The village of Ainchana has high consumption of fertilizers, high literacy rate and high irrigated area and good economic conditions whereas Kaimawali has canal irrigation and tube-well irrigation with high consumption of fertilizers. The two villages of Tappal block i.e. Takipur and Hetalpur record high use of tractors with cultivators, tillers and large holding of farmers.

There are six villages namely, Ektajpur (0.203), Pikhlauni (0.082), Pilkhuni (0.049), Kasison ( -0.042 ), Kaithwari ( -0.205 ) and Boner ( -0.216 ) that record medium level of agricultural development. The village Pilkhuni has highest sprayer and tube-well irrigation whereas Ektajpur has good irrigation facilities.

The low agricultural development has been confined in ten villages, namely Makhdum Nagar (lowest score -0.762), Tejpur (-0.702), Alipur (-0.660), Luosara Bisawan (-0.620), Faridpur (-0.548), Rahmapur ( -0.473 ), Markhi ( -0.451 ) Elampura ( 0.372 ), Gidaura ( -0.341 ) and Taraichi ( -0.293 ). Poor technology, poor irrigation facilities and small land holdings are the causes for low level of agricultural development in these villages.

### 7.11 Relationship between Agricultural Land Use and Agricultural Development

The relationship between agricultural land use and agricultural development is analyzed by regression technique. Table 7.13 shows the Karl Pearson correlation between major group variables of agricultural development and agricultural land use. It is clearly seen that agriculture land use is positive correlation with overall agricultural development with value of 0.659 at a 1 percent significant level. The agricultural land use is positively correlated with all variables of agricultural development. Out of all major groups of agricultural development, land holding is highly affected agricultural land use. The coefficient value of correlation between agricultural land use and land holding is 0.761 at 1 percent significant level. It shows that large land holdings have high cropping intensity

Table 7.13 Correlation between Agricultural Land Use and Variables of Agricultural Development

| Variables | $\mathrm{X}_{1}$ | $\mathrm{X}_{2}$ | $\mathrm{X}_{3}$ | $\mathrm{X}_{4}$ | $\mathrm{X}_{5}$ | $\mathrm{X}_{6}$ | $\mathrm{X}_{7}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathrm{X}_{1}$ | 1 |  |  |  |  |  |  |
| $\mathrm{X}_{2}$ | $0.417^{*}$ | 1 |  |  |  |  |  |
| $\mathrm{X}_{3}$ | $0.428^{*}$ | 0.025 | 1 |  |  |  |  |
| $\mathrm{X}_{4}$ | $0.692^{* *}$ | 0.294 | $0.646^{* *}$ | 1 |  |  |  |
| $\mathrm{X}_{5}$ | $0.761^{* *}$ | $0.409^{*}$ | $0.606^{* *}$ | $0.406^{*}$ | 1 |  |  |
| $\mathrm{X}_{6}$ | $0.637^{* *}$ | $0.482^{*}$ | $0.483^{* *}$ | $0.553^{* *}$ | $0.721^{* *}$ | 1 |  |
| $\mathrm{X}_{7}$ | $0.659^{* *}$ | 0.293 | $0.934^{* *}$ | $0.809^{* *}$ | $0.520^{* *}$ | $0.654^{* *}$ | 1 |

$\mathrm{X}_{1-}$ Agricultural Land Use, $\mathrm{X}_{2}$ - Human Resource, $\mathrm{X}_{3}$ - Technology, $\mathrm{X}_{4}$ - Irrigation, $\mathrm{X}_{5 \text { - }}$ Land Holdings, $\mathrm{X}_{6}$ - Finance, $\mathrm{X}_{7}$ - Overall Agricultural Development

Table 7.14 Model Summary

| Model | R | $\mathrm{R}^{2}$ | Adjusted <br> $\mathrm{R}^{2}$ | Std. Error of <br> the Estimate | Change Statistics |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $.871^{\mathrm{a}}$ | .758 |  |  | .758 | 14.897 | 4 |

a. Predictors: (Constant), Land Holding, Technology, Human Resource, Irrigation, Finance

Table 7.15 ANOVA

| Model | Sum of <br> Squares | df | Mean <br> Square | F | Sig. |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Regression | 1.185 | 4 | .296 |  |  |
| Residual | .378 | 19 | .020 | 14.897 | .000 |
| Total | 1.562 | 23 | .02 |  |  |

a. Predictors: (Constant), Land Holding, Technology, Human Resource, Irrigation, Finance
b. Dependent Variable: Agricultural Land Use

Table 7.16 Coefficients

| Model | Unstandardized | Coefficient Standardized |  | t | Sig. |
| :--- | :---: | :---: | :---: | :---: | :---: |
|  | B | Std. Error | Beta |  |  |
| Constant | .020 | .029 |  | .684 | .502 |
| Human Resource | .020 | .050 | .053 | .410 | .686 |
| Technology | -.009 | .050 | -.027 | -.177 | .041 |
| Irrigation | .232 | .080 | .468 | 2.898 | .009 |
| Land Holding | .261 | .062 | .557 | 4.236 | .000 |
| Finance | .213 | .064 | .442 | 2.236 | .005 |

a. Dependent Variable: Agricultural Land Use
and high yield. The correlation coefficient of irrigation variables also show a positive correlation with agricultural land use i.e. 0.692 value. It is also significant positive relation with technological factors and human resource factors i.e. coefficient correlation value of 0.428 and 0.417 respectively at 5 percent significant level. Table 7.13 indicates that variables of irrigation are significant positive correlation with technological variables by coefficient value of 0.646 . There is positive correlation of land holdings with human resources and irrigation facilities ( 0.409 and 0.406 respectively) at 5 percent significance level. The correlation coefficient value between agricultural technology and land holdings is 0.606 at 1 percent significance level. The finance variables are also significantly correlated with other variables at 1 percent and 5 percent significance level. It is highly positively significant with land holdings by coefficient value of 0.721 . It means large land holdings have good irrigation facilities and finance. The variables of technology, irrigation, finance and land holding bears significant positive correlation with an overall agricultural development i.e. $0.934,0.809,0.654$ and 0.520 r value respectively. There is no relation of variables of human resources with agricultural development.

The table of model summary shows that the multiple coefficients (R) using all variables of agricultural development is 0.871 and the adjusted $R^{2}$ is 0.70 . It means that 70 percent of the variance in agricultural land use can be estimated by the combination variables of human resource, technology, irrigation and land holdings. The coefficient table 7.16 indicates that p value for human resources is 0.686 which is insignificant. It rejects relationship between human resources and agricultural development. The p value for irrigation, finance and land holdings are $0.009,0.005$ and 0.000 respectively which is significant with agricultural development at 1 percent significance level whereas for agricultural technology, p value is 0.41 which is less than 0.05 . It means that agricultural technology is significantly positively related with agricultural development at 5 percent significance level. The ANOVA table 7.15 shows that the value of F is 14.90 that is statically significant. It indicates that the combination of all variables significantly combine together to predict agricultural land use.

The scatter plot 7.20 shows the relationship between agricultural land use and agricultural development. The value of $R^{2}$ is 0.43 , therefore the value of $r$ is 0.86 which is statistical significant. It means that the points fit the regression line pretty well.

Table 7.17
Variables of Agricultural Land Use of Selected Villages in Aligarh District

| Symbol | Description of Variables |
| :--- | :--- |
| $\mathrm{X}_{1}$ | Area under rice (percent) |
| $\mathrm{X}_{2}$ | Area under wheat (percent) |
| $\mathrm{X}_{3}$ | Area under millet (percent) |
| $\mathrm{X}_{4}$ | Area under maize (percent) |
| $\mathrm{X}_{5}$ | Area under mustard (percent) |
| $\mathrm{X}_{6}$ | Area under potato (percent) |
| $\mathrm{X}_{7}$ | Area under pulses (percent) |
| $\mathrm{X}_{8}$ | Yield of rice (quintals/hectare) |
| $\mathrm{X}_{9}$ | Yield of wheat (quintals/hectare) |
| $\mathrm{X}_{10}$ | Yield of millet (quintals/hectare) |
| $\mathrm{X}_{11}$ | Yield of maize (quintals/hectare) |
| $\mathrm{X}_{12}$ | Yield of mustard (quintals/hectare) |
| $\mathrm{X}_{13}$ | Yield of potato (quintals/hectare) |
| $\mathrm{X}_{14}$ | Yield of pulses (quintals/hectare) |
| $\mathrm{X}_{15}$ | Cropping intensity |
| $\mathrm{X}_{16}$ | Gross cropped area in hectares |

### 7.13 Composite Index of Agricultural Land Use vs. Agricultural Development

The composite index of agricultural land use and agricultural development is depicted in Figure 7.19. It is seen from this figure that there are five villages, namely, Hetalpur, Ainchana, Govali, Taharpur, and Kaimawali which show a high level of agricultural land use and high level of agricultural development. The high level of agricultural land use and medium level of agricultural development is visible in Pikhlauni and Ektajpur. These villages have good irrigation facilities. The villages of Takipur, Bistauli and Khurrampur


Figure 7.19
are characterized with medium level of agricultural land use and high level of agricultural development. There are three villages (Kasison, Kaithwari and Boner) that depict medium level of agricultural land use and agricultural development. The medium level of agricultural land use and low agricultural development is seen in four villages i.e. Elampura, Markhi, Faridpur and Rahmapur. The village of Pilkhuni is characterized by low agricultural land use and medium level of agricultural development. There are six villages namely Tejpur, Luosara Bisawan, Alipur, Taraichi, Makhdum Nagar and Gidaura which have low level of agricultural land use with low level of agricultural development.


Figure 7.20

If we compare the primary data with secondary data, we find that result of both is more or less similar. Cropping pattern of villages is matched with blocks in which villages are located. The level of agricultural development shows that there are four blocks (Tappal, Iglas, Akrabad and Atrouli) in 2011 which shows high level of agricultural development and villages of these blocks also show high level of agricultural development. The low level of agricultural development has been recorded in three blocks i.e. Chandaus, Bijouli and Gangiri and villages of these three blocks also recorded
low level of agricultural development. There is a slight difference in medium level of agricultural development between villages and blocks. There are five blocks namely, Khair, Jawan, Lodha, Dhanipur and Gonda that record medium level of agricultural development. Except Jawan block, at least one medium level of village comes under each medium level of blocks. Both villages of Jawan block show low level of agricultural development. About ninety percent primary data is matched with secondary data and it validates the secondary data,

## HYPOTHESIS TESTING

Hypothesis has been tested by Karl Pearson correlation method. All research hypotheses are accepted and null hypotheses are rejected at 1 percent or 5 percent significance level.

## $\mathrm{H}_{1}$ - Agricultural development is directly related to agricultural technology.

Table 7.18

|  |  | Agricultural <br> Development |
| :--- | :--- | :---: |
| Agricultural | Pearson Correlation | $0.934^{* *}$ |
| Technology | Sig. (2-tailed) | 0.000 |
|  | N | 24 |

**Correlation is significant at the 0.01 significance level (2-tailed).

From the table 7.18, it can see that the correlation coefficient between agricultural technology and agricultural development is 0.934 and the p -value for two-tailed test of significance less than 0.0005 (value less than 0.0005 are shown as 0.000 in SPSS outputs). From these figures, we can conclude that there is a strong positive correlation between agriculture technology and agricultural development and this correlation is significant at the significant level of 0.01 . Therefore, this research hypothesis is accepted. $\mathrm{H}_{2}$ - The high adoption of agricultural technology is directly proportionate to size of land holding.

The output produced is shown in table 7.19. This table shows that correlation coefficient between agricultural technology and size of land holdings is 0.606 . The significance value for this correlation coefficient is 0.020 which is less than 0.05 .

Table 7.19

|  |  | Agricultural <br> Technology |
| :--- | :--- | :---: |
| Land holdings | Pearson Correlation | $0.606^{*}$ |
|  | Sig. (2-tailed) | 0.020 |
|  | N | 763 |

*Correlation is significant at the 0.05 significance level (2-tailed).
Therefore, it can be concluded that there is a significant positive relationship between size of land holdings and agricultural technology at 5 percent significance level. It means that large land holdings farmers can adopt agricultural innovations practices. They spend money to purchase agriculture instruments because of their good economic condition and social status whereas small holdings and semi-medium holdings farmers can afford to adopt agricultural technology because of bad economic condition. They can hardly invest money in adopting in agricultural technology practices.

## $\mathrm{H}_{3}$ - The farmers having adequate irrigation are more adoptive of agricultural technology as compared to others.

Irrigation plays a significant role in adopting agricultural technology. Without irrigation, fertilizers and HYV seeds can not be used. The relationship between agriculture technology and irrigation can be tested by Karl Pearson correlation technique.

Table 7.20

|  |  | Agricultural <br> Technology |
| :--- | :--- | :---: |
| Irrigation | Pearson Correlation | $0.646^{* *}$ |
|  | Sig. (2-tailed) | 0.000 |
|  | N | 763 |

**Correlation is significant at the 0.01 significance level (2-tailed).
The test result is shown in table 7.20. It is clearly seen from this table the correlation coefficient value between irrigation and agriculture technology is 0.646 . The corresponding two-tailed $p$ value is 0.000 which is less than 0.01 . This means that those farmers having adequate irrigation are more adoptive of agricultural technology and vice versa at $1 \%$ level of significance.

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# CONCLUSION 

 $\mathcal{A N D}$SUGGESIIONS

The pattern of Land use is a dynamic phenomenon because it changes with time and space. The land use study acquires special significance in the present day. It needs scientific study for solving the problems related to land use. The systematic and scientific study of land use in Aligarh district has not been done yet.

Agricultural development plays an important role in the economic development of the country. The economist, sociologist, political thinkers, planners and administrators hold the view that success of economic development programmes depends ultimately on the agricultural development. Aligarh district play an important role in economic development in Uttar Pradesh. Aligarh district is located in the Ganga-Yamuna Doab having monsoon climate, fertile soil, and good irrigation. The Ganga and the Yamuna make the east and west border of the district respectively. The other tributaries like Neem, Kali, Sengar and Karwan have played an important role in the fashioning of the district.

The pattern of land use directly or indirectly reflects the level of agricultural change in a region. Agriculture is the most important sector of the economy in the study area, covering about 80 percent area under agricultural land use. Therefore, land use planning is necessary to maintain the ratio between population and production. The pattern of land use and agricultural development is considered interrelated. Findings of this research will help to design plans and formulate policies for the agricultural development of the area and proper utilization of land at micro level.

Land use/land cover has been classified into seven classes in the study area i.e. built-up land, agricultural land, fallow land, vacant land, tree plantation, water bodies, wet lands and sandy area. During the period of fifteen years (1996 to 2011), positive changes have been noticed in built-up land, agricultural land and sandy area whereas negative changes have been observed in fallow land, vacant land, tree plantation and wet lands. It is interesting to note that agricultural land has been recorded positive growth in study area due to transformation of vacant land into agricultural land. The area under agriculture increased from 78.86 percent in 1996 to 81.77 percent in 2011. There was 18519.41 hectares vacant land that has been transformed into agricultural land. The built-
up land has been recorded tremendous increase during fifteen years from 2.59 percent in 1996 to 6.85 percent in 2011. It has received threefold growth during these years because of expansion of settlements and roads. The settlements has been encroached the major area of agricultural land around the Aligarh city and towns. Tree plantation disappeared in the western part of the district and along the roads while it appeared more in the eastern part of the district. Water bodies do not constitute significant area because of, imageries were taken in the month of February and the volume of water is low at this time.

All blocks registered positive growth in built-up land out of which Lodha registered maximum positive growth i.e. 11.72 percent because major part of Aligarh city expanded in this block whereas Gonda received lowest positive growth i.e. 2.12 percent due to low development in block. Except Tappal and Gonda blocks, all blocks received positive change in agricultural land use. The highest positive change has been seen in Jawan (6.87 percent) followed by Chandaus block (6.80 percent) and Akrabad (6.10 percent). The reason for the high growth of agriculture land in these blocks is that the area under vacant lands observed more in these three blocks in 1996 and has been converted into agricultural lands in 2011. All blocks of district recorded negative change in area under vacant. In the year of 2011, four blocks of Koil tehsil i.e. Jawan, Lodha, Dhanipur and Akrabad which comprised Aligarh city have 4 to 5 percent area under vacant land because of the agriculture area around the city has been converted into vacant land for the purpose of settlements. Other blocks of the district have only about 2 percent areas under vacant in 2011. Except four blocks, Jawan, Atrouli, Bijouli and Gangiri, all blocks have registered negative change under tree plantation. The positive growth in these four blocks is due to increase in area under commercial tree plantations like mangoes plantation, guavas plantation, cultivation of eucalyptus and poplar (populas) tree.

Cropping pattern, crop ranking, crop combination and cropping intensity are significant elements of the agricultural land use which helps to know the pattern of crops. It is observed that cereals were dominant in all crops. It occupied 70 percent area in 1996 and 78 percent in 2011. Among cereals, wheat was dominant because of main dietary
habits of the people of the region. During 1996-97 to 2011-12, the area under wheat, rice and millet increased, out of which rice recorded tremendous increase by 13.12 percent. The coarse cereals (barley and maize), pulses and mustard registered negative change during these fifteen years. It is found that sugarcane and potato were two cash crops of study region. It is noted that the area under sugarcane decreased whereas the area under potato increased by 3.52 percent. After rice cultivation, the area under potato recorded maximum positive change in all crops.

The study of trends of area, production and yield of individual crops revealed that rice recorded maximum positive growth in area, production and yield during 1996-97 to 2011-12. The overall linear growth rate of area under rice increased by 542.58 percent while production increased by 904.23 percent. After rice, potato observed maximum positive growth in area, production and yield. Its areal extent increased by 458.28 percent and its production increased by 608.14 percent during the period studied. The linear growth rates of area under wheat increased by 17.52 percent while the quantum of production increased by 37.77 percent. The area and production under barley and maize declined while the area and production of millet increased during this period.

The area and production under pulses was declined by 51.40 percent and 60.75 percent respectively. Arhar was the leading crop in among all pulses of district. Masur ranked second pulse after Arhar. But only one pulse i.e. Urad recorded increase in area by only 2.31 percent whereas the positive growth in production has been found in two pulses i.e. Urad and Masur. The area under mustard was declined by 55.74 percent and production decreased by 57.23 percent. The area and production of sugarcane also recorded negative growth i.e. 38.98 percent and 35.14 percent during fifteen years. Pea and Gram has insignificant area and has almost finished in the year of 2011. All crops recorded positive growth in yield except mustard because of improved agricultural facilities like irrigation facilities, mechanization, use of fertlisers, and high yielding varieties of seeds. It is observed that cotton cultivation has almost finished in the region because of unremuneartive price. Sugarcane crop also stands at poor condition like cotton because of inadequate marketing facilities.

Wheat was the first rank crop in all blocks in both years. In 1996-97, millet, maize and pulses occupied second place out of which millet was dominant whereas in 2011-12, rice came as second crop replacing millet and maize due to good price and better irrigation facilities. Mustard was dominant as third rank crop in 1996-97 while millet was third rank crop in 2011-12. Doi's method has been applied to calculate the cropcombination regions. Two to five crop combinations regions have been observed in Aligarh district.

It is significant to note that as compared to the earlier period, a marked acceleration in the growth of cropping intensity has taken place during 2011-12. This is due to technological advancement of agriculture. Tappal recorded maximum positive growth in cropping intensity followed by Gonda whereas Dhanipur recorded maximum negative growth in cropping intensity during 1996-97 to 2011-12 because of low improvement in agricultural technology.

Productivity is most important dimension of agricultural development. Crop productivity regions have been demarcated into four major groups of crops: cereals, pulses, oilseeds and cash crops. The study of productivity regions for the two period of time indicates that during 1996-97 and 2011-12, there was a shifting of blocks of high, medium and low productivity. During 1996-97, the high productivity of cereals has been found in four villages namely, Tappal, Jawan, Lodha and Atrouli. However, in 2011-12, the high productivity region of cereals has changed. It added one new block i.e. Dhanipur in this category whereas Gonda, Iglas and Gangiri recorded low productivity of cereals in both years. It is seen that high productivity regions of pulses cover two blocks i.e. Jawan and Atrouli in 1996-97 and added Lodha and Akrabad in this category during 2011-12 whereas Lodha and Akrabad come under the low productivity regions of pulses. There are two blocks namely Khair and Gangiri which fall under low productivity regions of pulses in 1996-07 and 2011-12. The high productivity of oilseeds increased from two blocks in 1996-97 to six blocks in 2011-12. Jawan and Akrabad were common blocks in both periods. The high productivity regions of cash crops comprised three blocks i.e. Tappal, Akrabad and Iglas in 1996-97 and two blocks i.e. Atrouli and Iglas in 2011-12. The low productivity of cash crops has been noticed in Khair, Lodha, Dhanipur, Gonda
and Bijouli in 1996-97 whereas it was low in Chandaus, Lodha and Gangiri in the year of 2011-12.

Composite index of productivity regions has been prepared by combining all groups of crops. It indicates that productivity range increased during 2011-12. The high productivity regions of crops have decreased from four blocks i.e. Tappal, Jawan, Akrabad and Atrouli in 1996-97 to two blocks i.e. Iglas and Atrouli in 2011-12. It is seen that Atrouli was high in productivity in both years due to good mechanization. The low productivity regions have been noticed in Khair, Lodha, Gonda and Gangiri in 1996-97 and Khair, Chandaus and Gangiri in 2011-12. It has been observed that Gangiri has low productivity in all groups of crops in both years due to low agriculture mechanization and infrastructures.

Correlation matrix has been used to see the relationship between variables of agricultural development. During 1996-97, it is seen that crop productivity is significantly positively correlated with variables of irrigation and soil nutrients whereas during 2011-12, it is significantly positively correlated with sources of irrigation, soil nutrients and advance agriculture instruments. Literacy is positively correlated with advance agricultural techniques and negatively correlated with traditional plough. It is observed that cropping intensity is significantly positively correlated with productivity, irrigation and mechanization in 2011-12 while it is positively correlated with wooden and iron plough in 1996-97.

Factor analysis technique is used for assessing a small number of factors underlying a large number of variables. The discussion reveals that four factors of agricultural development which together contribute 79.47 percent and 74.38 percent of the total variance in the year 1996-97 and 2011-12 respectively. During 1996-97, factor 1 (cropping intensity, traditional plough and infrastructure) explains 29.98 percent of the total variance. The variables which have positive loadings in factor 1 are percentage area under food grains, cropping intensity, ploughs, electrified villages and pakki roads. This factor explains that cropping intensity is high due to traditional ploughing and infrastructure facilities. The result of factor score1 represents that high factor scores have
been noticed in the eastern part of the region, extending over the blocks Akrabad, Atrouli, Bijouli and Dhanipur whereas low grade factor scores is extended over western part of the district, comprising Tappal, Khair, Chandaus, Gonda and Iglas. The second factor i.e. productivity and soil quality accounts 19.77 percent of the total variance. It has strongly positively loading with agricultural productivity and soil quality. This factor indicates that productivity is affected by soil quality. The high factor score of factor 2 is concentrated in northern part of the region including Tappal, Khair, Jawan, Atrouli and Dhanipur whereas low scores have been confined in four blocks i.e. Gonda, Iglas, Bijouli and Gangiri. The third factor (literacy and mechanization) contributes 15.79 percent of the total variance whereas the fourth factor (irrigation facilities) shares 13.91 percent of the total variance. The high factor scores of third factor has been noticed in four blocks namely, Chandaus, Jawan, Lodha and Iglas whereas the high scores of fourth factor lies in five blocks namely, Tappal, Jawan, Dhanipur, Akrabad and Bijouli. The low scores of third factor and fourth factor is concentrated in five blocks (Tappal, Khair, Atrouli, Bijouli and Gangiri) and four blocks (Chandaus, Lodha, Atrouli and Gangiri) respectively.

During 2011-12, the first factor (productivity, literacy and mechanization) contributes 30.43 percent of the total variance. It is seen that this factor share only just half ( 15.79 percent) in the year of 1996-97. It means mechanization play a significant role in agricultural development in 2011-12. High scores of factor 1 have been found in four blocks i.e. Tappal, Khair, Iglas and Atrouli whereas it is low in three blocks i.e. Gonda, Bijouli, and Gangiri. The second factor (fertilizers and infrastructure) and third (irrigation facilities) factor share 15.62 percent and 15.01 percent of the total variance respectively. High factor scores of second factor appeared in four blocks namely, Jawan, Lodha Dhanipur, and Atrouli whereas low factor scores of second factor is concentrated in four blocks namely, Tappal, Khair, Gonda, and Gangiri. The high factor scores of third factor has been noticed in three blocks namely, Akrabad, Gonda and Iglas whereas it is low in four blocks i.e. Tappal, Chandaus, Lodha and Bijouli. The fourth factor explains 13.31 percent of the total variance. It has positive loadings with cropping intensity and variables of net irrigated area and gross irrigated area. The factor scores of factor 4 (cropping
intensity and irrigated area) are high in Tappal, Akrabad and Atrouli and low in Chandaus, Lodha and Gangiri.

The levels of agricultural development in Aligarh district has been calculated with the help of $z$-score by selecting twenty-two variables for two point of time i.e. 1996-97 and 2011-12 and all blocks have been divided into three levels of agricultural development i.e. high, medium and low. During 1996-97, the high agricultural development has been observed in five blocks namely, Tappal, Jawan, Dhanipur, Akrabad and Atrouli whereas high agricultural development has been noticed in four blocks namely, Tappal, Akrabad, Iglas and Atrouli in the year of 2011-12. The medium level of agricultural development has been noticed in four blocks namely, Chandaus, Gonda, Iglas, and Bijouli in 1996-97 whereas it was medium in five villages namely, Khair, Jawan, Lodha, Dhanipur and Gonda in 2011-12. The low level of agricultural development has been seen in three blocks i.e. Khair, Lodha and Gangiri in 1996-97 and also three blocks, namely, Chandaus, Bijouli and Gangiri in 2011-12. It is seen that during span of fifteen years, Iglas changed their position from medium level to high level because of good irrigation facilities, high mechanization. Chandaus block fall from medium to low level whereas Gangiri block has low level of agricultural development in both years due to low productivity and low mechanization and poor irrigation and infrastructures facilities. The farmers belonging to the villages of low level of agricultural development are not in good position and are not enthusiastic to generate more returns.

The result of primary survey in twenty-four villages of Aligarh district revealed that young and highly educated people are not interested in agriculture occupation. It is analyzed from the field survey that size of land holdings is small and fragmented. Only 0.5 percent size of land holdings are more than 10 hectares. On the contrary to this, 32.77 percent respondents have small size of land holdings which are high in all size of land holdings. It is seen that small and marginal farmers are unable to adopt effective utilization of agricultural practices as comparison to large farmers.

The study of cropping pattern of selected villages that cropping pattern is influenced by a number of factors like size of land holdings, irrigation facilities, market
distance, soil quality and price. Wheat shares 29.87 percent area and it is cultivated by all size of farmers. In Rabi season, only large farmers grow other crops with wheat whereas small and marginal farmers cultivate only wheat crop for their survival. It is analyzed that rice is dominant crop in those villages where canal irrigation is available because rice cultivation requires high amount of water whereas millet is dominant in those villages where canal irrigation is not available. It is seen that only large, medium and semimedium farmers cultivate rice with the help of tube-well irrigation in those areas where canals irrigation is inaccessible because they can afford the charges for tube-well irrigation. Potato cultivation is influenced by price and soil quality. It is increasing because of good price. The area under potato is high in Taharpur, Kaimawali, Ektajpur and Gidaura due to suitable soil quality. Vegetable farming is determined by market distance, accessibility and connectivity from the village. Vegetable farming occupies in those villages which are located near to city or town and vegetable mandies are located near to villages with good accessibility. Maize and Pulses share low area due to damage of crops by wild animals. The area under Maize is high in villages of Atrouli, Bijouli and Gangiri blocks. In these villages, maize is cultivated by high technology. Mustard, barley and cotton account about 1 percent area. The area under cotton is high in Markhi and Elampura villages due to suitable soil conditions. Sugarcane covers only 0.79 percent area due to low economic benefits and farmers do not get price at the time.

After surveying of twenty four villages, it is concluded that ninety nine percent farming is done with the help of tractors. Traditional method of ploughing by wooden plough is almost finished. It is observed that large, medium and semi-medium farmers have their own agricultural implements and sources of irrigation whereas small and marginal farmers hire from owners on rent. Only large farmers have advance instruments like combine and rotavator and these agriculture instruments are not available in each village. It is seen that farmers have adopted mechanized farming at great level but they are unaware of some scientific techniques of agriculture. Among them, farmers are not aware of soil testing, seed treatment before sowing and line sowing of seeds.

At present, canal and tube-wells are the major source of irrigation in the study area but there is a lot of variation at village level. There is no doubt that public and
private tube-wells have brought in huge unirrigated area under irrigation. The farmers have been tempted to switch over from traditional to modern agriculture especially in those villages where irrigation facilities have improved.

As in case of chemical fertilizers, a vast majority of farmers have adopted chemical fertilizers. However, wide variations have been observed in the rate of application per hectare in sample farms. The factors that have been found to have significant effect on the use of fertilizer per hectare by farmers are tenancy, extent of availability of irrigation and fertilizers intensive crops.

Only about fifteen percent framers have been found to be in such beneficial contact with co-operative societies. Clearly, the inadequate quantity of services has deprived many farmers in the region. There are about forty-five percent farmers who have Kisan Credit Cards. Only large farmers take Kisan Credit Cards. During the field survey, it is analyzed that very few farmers are benefitted by the cooperative societies. Most of the time, amount of seeds and fertilizers is not sufficient and machineries are not available. In this context, the role currently being played by co-operative societies and financial institutions is not satisfactory.

With the help of z-score, villages have been categorized into high, medium and low. The high level of agricultural development has been observed in eight villages i.e. Takipur, Hetalpur, Ainchana, Bistauli, Khurrampur, Govali, Taharpur and Kaimawali due to large size of land holdings, good irrigation facilities with advance agricultural technology. On the contrary to this, low level of agricultural development has been confined in nine villages, namely Makhdum Nagar, Luosara Bisawan, Tejpur, Alipur, Faridpur, Rahmapur, Elampura, Markhi and Taharpur. Poor technology, poor irrigation facilities and small land holdings are the causes for low level of agricultural development in these villages. There are seven villages, namely, Pilkhuni, Ektajpur, Pikhlauni, Kasison, Boner, Kaithwari and Tarainchi that record medium level of agricultural development. The village Pilkhuni has the maximum sprayer and tube-well irrigation whereas Ektajpur has good irrigation facilities. It is concluded that there is ample scope for increasing agricultural development which can be achieved by improving and
extending irrigation facilities, using new varieties of seeds, fertilizers and motivating farmers to adopt the modern techniques in agriculture without harming the environment.

It is observed that agricultural land use is significantly positively correlated with variables of agricultural development. It has been analyzed with the help of regression that 70 percent of variance in agriculture land use can be estimated by the variables of agricultural development. It is concluded that irrigation, size of land holdings and agricultural technology are mutually correlated with each other. The findings of the field study support the hypothesis that agricultural development is directly related with agricultural technology, size of land holdings and irrigation facilities.

## Suggestions

- It is realized that horizontal expansion of agriculture is not possible in future. Therefore, there is enough scope for vertical expansion of agriculture by increasing cropping intensity through proper land utilization and management.
- Those lands which are unfit for cultivation as also for growing grass need to be put under forests.
- Forest area should be planted on the vacant land especially in the western part of the district to maintain the environment balance. Public and private sector both should be participated in tree plantation programme. Private individuals could also grow various varieties of medicinal plants if they could be informed about their commercial value.
- Two crops can be grown at the same season by selecting right combination, cauliflower or garlic or black gram with sugarcane, turmeric and ginger with arhar and maize.
- It is noted that commercial crops are insignificant in the regions. Commercial crops should be promoted.
- Such type of crop gene should be developed which requires little irrigation and short duration for maturing.
- The productivity, workability and conserve-ability of the soil types need to be studied while considering whether a particular piece of land is suitable for agriculture or not.
- Productivity could be increased by diffusion of relevant technology and knowledge, transportation and marketing and development of infrastructure facility.
- Special attention should be paid for canal irrigation because canals are dried in all seasons except rainy season. For managing water at all time, rain water harvesting procedure should be adopted.
- At least, a local body village information system should be established at village level and it will provide update, accurate, timely data and information of a village after every cropping season. Therefore, it will help in village level planning and development. Agricultural scientist should be appointed at village level for giving the proper guidance to farmers.
- It has been observed that instead of using Hybrid seeds, farmers prefer local varieties of seeds because hybrid seeds can not be again sown in field and it will be useless for next crop. Therefore, agricultural scientist should develop such type of hybrid seeds that can be use for next two or three crops.
- Foundation seeds should provide to farmers instead of certified seeds. It is also suggested that fertilizers and seeds should be pure.
- Modern technology requires adequate knowledge. It is remarked that famers are ignorant of agricultural techniques and poor in skill. Therefore, training should be provided for farmers for improvement in productivity and development.
- It has been observed at a micro level that yield is not increasing in those areas where same crop is continuous practicing. It is essential requirement of crop rotation in such areas for improving crop yield.
- It is clear after the field survey that about sixty percent farmers belong to small and marginal farmers. Therefore, they are the backbone of economy. These farmers do not possess adequate means to improve their method of cultivation. Therefore, policies should be made for small and marginal farmers. A separate
society should be made only for small and marginal farmers. This society should provide machineries for cultivation on a reasonable price on rent.
- The practice of chemical fertilizers is losing soil fertility. Bio-fertilizers should be use instead of chemical fertilizers. Bio-fertilizers are considered as an effective, cheap and renewable supplement to chemical fertilizers. Farmyard manures like animal dung, bagasse, weeds, straw, sewage, sludge, oil cakes, vegetables processing waste, rice husks and seeds weeds can be a good source of organic matter to increase the fertility of soil by composting and recycling of these waste products. Green manure crops help in making the soil fertile. Green leguminous crops, like dhaincha, barseem and pulses, when they attain some height, are ploughed in the field along with their roots, stems and leaves. This helps all the nutrients obtained from the soil to go back to the soil.
- Inadequate electricity supply is major problem for running tube-wells. Therefore, supply of electricity should be adequate at the time of crop irrigation.
- It is notices that farmers face critical problem for storing to their crops. In absence of storing, they dump their crops in market at very low price. Sometimes, crops like wheat and potato spoil in the field. Therefore, small cold storages or granaries should be opened at village level especially in the eastern part of the district. Hence, it eliminates dumping of excess crops in the market yard.
- To check the soil nutrient loss, it is necessary to demonstrate the proper methods of manure application through visual aids to the farmers.
- Encouraging small and marginal farmers including backward castes to maintain the increased production tempo by providing different inputs on subsidy reasonable price.
- During field survey, it is gathered that farmers are not aware about credit system. Illiteracy and ignorance are major hindrance before the farmers to familiar with the regulation of banks. Therefore, monetary support, loan facilities and insurance policies should be provided to all size of land holdings without hindrance and rules should be liberalized. Zero percent interest loans should be available for poor farmers.
- It is analyzed that farmers do not adopt new technologies. The reason behind it is that they need zero cost technology. For solving this problem, the only way to convince farmers is that technologies should be applied practically in front of them and let them see with their eyes how much more benefits and profits they can get in such application. For conducting practical demonstration, suggestion is that government takes some land from farmers on rent and applies new techniques on these lands. It will be good demonstration before farmers.
- Finally it can be said that Chandaus, Bijouli and Gangiri blocks and villages of these three blocks namely, Elampura, Markhi, Tejpur, Faridpur, Luosara Bisawan, Taraichi, Alipur, Makhdum Nagar, Rahmapur and Gidaura villages show low agricultural development which draw our attention for priority basis development so that these blocks and villages can be matched with other area. Gangiri block requires special attention for development because there is no improvement in this block during fifteen years.


## APPENDIX I

Standard Scores of Variables of Agricultural Development in Aligarh District (1996-97)

| Blocks | $\mathrm{X}_{1}$ | $\mathrm{X}_{2}$ | $\mathrm{X}_{3}$ | $\mathrm{X}_{4}$ | X | $\mathrm{X}_{6}$ | $\mathrm{X}_{7}$ | $\mathrm{X}_{8}$ | $\mathrm{X}_{9}$ | $\mathrm{X}_{10}$ | $\mathrm{X}_{11}$ | $\mathrm{X}_{12}$ | $\mathrm{X}_{13}$ | $\mathrm{X}_{14}$ |  | $\mathrm{X}_{16}$ | $\mathrm{X}_{17}$ | $\mathrm{X}_{18}$ | $\mathrm{X}_{19}$ | $\mathrm{X}_{20}$ | $\mathrm{X}_{21}$ | $\mathrm{X}_{22}$ | CSS |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ta | 1.5 | 0.548 | 0.57 | -0.481 | -0.261 | -0.5 | 0.425 | -1.284 | 1.4 | 2.627 | $-1.247$ | -1.165 | -0.244 | 1.604 | -1.154 | $-1.415$ | 1.362 | 0.765 | 0.282 | $-2.112$ | 1.619 | -0.360 | 0.117 |
| Khair | -0.4 | 1.138 | 0.032 | -0.502 | -0.933 | -0.71 | 0.601 | -1.01 | 1.2 | 0.440 | -0.250 | -1.208 | -0.46 | -0.340 | -0.990 | -1.553 | -0.025 | 0.197 | 0.039 | -0.649 | 0.524 | -0.606 | -0.253 |
| Chandais | -0.242 | 1.034 | -0.17 | -0.376 | 2.215 | -0.031 | 0.777 | -0.25 | -0.5 | 0.090 | -0.4 | -0.132 | 0.8 | 1.900 | -1.065 | -0.194 | -0.738 | -0.943 | 9 | $-1.039$ | 0.524 | 74 | 0.044 |
| Jaw | 1.4 | 0.4 | -1. | -0. | 0.0 | 0.889 | 0. | 0. | 1.272 | -0 | -0 | 1.038 | 0.231 | -0.428 | -0 | -0.230 | 0.334 | 1.116 | 74 | 6 | 4 | 23 | 0.094 |
| Lod | 0.26 | 0.461 | -1.80 | -0.8 | 0 | -0. | 0.029 | -0 | 0.1 | 0.294 | -0. | $-0.310$ | 2.247 | -0.190 | -0.511 | -0.334 | -1.297 | -1.182 | 1.161 | 0.458 | -0.524 | -0.967 | -0.204 |
| Dhanipur | 0.41 | 0.080 | 0.340 | -0.712 | 0.407 | 1.63 | -0.147 | 1.51 | 0.68 | -0.063 | -0.341 | $-0.924$ | -0.585 | -0.591 | -0.150 | 1.3 | 0.034 | -0.082 | -1.912 | 1.227 | 0.524 | 0.701 | 0.155 |
| Ak | -0. | -0.042 | -0, | 0. | -0 | 1.698 | 0.469 | 1.194 | -0 | -1.096 | -0. | -0.563 | $-0.590$ | -0 | 0.435 | -0 | 0.2 | 2.044 | -1.586 | 0.344 | 0.524 | 1.403 | 77 |
| Go | -0. | 0.288 | 1.61 | -0.523 | -1.01 | -1. | 0.249 | -1. | -1.6 | 0.464 | 0.096 | 2.0 | 0.929 | 0.524 | 0.018 | -0.198 | 1.634 | -0.243 | -0.020 | -0.519 | -1.190 | 0.272 | -0.038 |
| Iglas | -1.1 | 0.288 | -0.50 | -1.257 | 0.538 | -1.082 | 0.337 | -0.77 | -0.206 | 0.184 | 0.44 | 1.205 | 0.63 | 0.927 | -0.610 | -0.426 | 0.747 | -0.279 | 0.374 | 0.906 | 0.048 | 0.819 | 0.051 |
| Atrouli | 1.248 | -0.424 | 1.014 | 0.841 | -1.343 | 0.333 | 0.337 | 0.574 | 0.063 | -0.882 | 0.155 | -0.391 | -1.135 | -0.989 | 1.602 | 1.833 | -1.649 | -1.216 | 0.977 | 1.156 | 0.524 | -0.504 | 0.097 |
| Bijouli | -0.265 | -2.177 | 0.504 | 1.513 | 1.162 | 0.297 | -3.006 | 1.134 | -0.744 | -0.974 | 0.677 | 0.341 | -0.977 | -1.026 | 1.948 | 0.665 | 0.230 | 0.628 | -0.128 | 0.520 | -1.190 | 0.813 | -0.003 |
| Gangiri | -1.417 | -1.673 | 0.609 | 1.890 | -0.500 | -0.390 | -0.411 | 0.304 | -0.851 | -0.688 | 2.670 | 0.086 | -0.869 | -0.705 | 0.580 | 0.693 | -0.866 | -0.803 | 0.617 | -0.629 | -1.904 | 1.227 | -0.138 |

Source: Computed by Researcher data obtained form Directorate of Agricultural Statistics, Aligarh

## APPENDIX II

Standard Scores of Variables of Agricultural Development in Aligarh District (2011-12)

| Blocks | $\mathrm{X}_{1}$ | $\mathrm{X}_{2}$ | $\mathrm{X}_{3}$ | $\mathrm{X}_{4}$ | $\mathrm{X}_{5}$ | $\mathrm{X}_{6}$ | $\mathrm{X}_{7}$ | $\mathrm{X}_{8}$ | $\mathrm{X}_{9}$ | $\mathrm{X}_{10}$ | $\mathrm{X}_{11}$ | $\mathrm{X}_{12}$ | $\mathrm{X}_{13}$ | $\mathrm{X}_{14}$ | $\mathrm{X}_{15}$ | $\mathrm{X}_{16}$ | $\mathrm{X}_{17}$ | $\mathrm{X}_{18}$ | $\mathrm{X}_{19}$ | $\mathrm{X}_{20}$ | $\mathrm{X}_{21}$ | $\mathrm{X}_{22}$ | CSS |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Tappal | 0.699 | 0.203 | 0.914 | -1.130 | -0.496 | 1.075 | 0.569 | 0.540 | 0.884 | 1.547 | 1.576 | 0.311 | 0.543 | 1.859 | -0.514 | -0.508 | -1.403 | -0.950 | 0.591 | -0.449 | -1.749 | -0.563 | 0.161 |
| Khair | -0.459 | 0.792 | 0.234 | -0.914 | -1.726 | -0.208 | 0.384 | -0.426 | 1.605 | -0.046 | 0.145 | -1.267 | 0.584 | 0.836 | -0.508 | -0.536 | 0.800 | 1.342 | -1.177 | 0.410 | -1.004 | -0.480 | -0.073 |
| Chandans | -0.444 | 0.828 | -0.228 | 0.518 | -0.927 | -0.040 | -3.028 | -0.399 | 0.369 | 0.603 | -0.775 | -0.914 | 0.373 | 0.611 | -0.352 | -0.269 | -0.390 | -2.022 | 1.395 | 0.016 | -0.585 | -0.433 | -0.277 |
| Jawan | 0.459 | 0.828 | -0.671 | 0.882 | -0.211 | 0.849 | 0.292 | -0.479 | -0.146 | 0.144 | -0.413 | -0.220 | -0.504 | -0.753 | -0.726 | -0.799 | -0.758 | -0.084 | 0.280 | 1.467 | 0.187 | -1.114 | -0.068 |
| Lodha | 0.777 | 0.110 | -2.511 | -0.289 | 0.633 | -0.761 | 0.015 | -0.412 | 0.781 | 0.825 | 0.867 | -1.093 | 1.337 | 0.894 | -0.074 | -0.138 | -1.181 | -0.923 | 0.728 | 0.375 | 1.055 | -1.718 | -0.032 |
| Dhanipur | 0.327 | 0.110 | -0.822 | 1.518 | 0.881 | 0.222 | 0.200 | -1.793 | 0.163 | 0.186 | 0.113 | -0.424 | 0.373 | 0.101 | -0.171 | 0.049 | 0.460 | -0.033 | -1.000 | 0.607 | 0.409 | 0.902 | 0.081 |
| Akrabad | 0.102 | -0.221 | 0.480 | 0.382 | 0.367 | 1.461 | 0.476 | 2.055 | -0.764 | -0.756 | -0.009 | 1.531 | 0.546 | 0.154 | 0.061 | -0.289 | 0.625 | 0.506 | -2.292 | -0.055 | 0.874 | 1.708 | 0.315 |
| Gonda | -0.323 | 0.718 | 0.640 | -0.0184 | -0.036 | -0.055 | 0.569 | 0.218 | 0.061 | 0.328 | -0.835 | 0.696 | 0.327 | -0.464 | -0.728 | -1.177 | 1.686 | -0.067 | 0.081 | -2.240 | -0.707 | 0.836 | -0.066 |
| Iglas | 1.373 | 0.608 | -0.209 | -2.152 | 1.469 | 0.339 | 0.476 | 0.057 | 0.575 | 1.148 | -0.800 | 1.362 | 0.891 | 0.445 | -0.808 | -0.998 | 1.455 | -0.337 | 0.616 | 0.607 | 0.122 | 0.685 | 0.315 |
| Atrouli | 0.904 | 2.228 | 0.253 | 0.291 | -0.055 | 0.536 | 0.569 | 1.344 | -2.000 | -1.104 | -1.124 | -0.887 | -1.142 | -1.452 | -0.190 | 1.493 | -0.117 | 0.680 | 0.728 | 0.948 | 1.919 | -0.817 | 0.137 |
| Bijouli | -1.192 | -2.099 | 0.838 | 0.257 | 1.506 | -1.519 | -0.261 | 0.111 | -0.146 | -1.717 | -0.710 | 1.215 | -1.620 | -0.934 | 1.491 | 1.378 | -0.617 | 1.547 | 0.604 | -0.485 | 0.041 | 0.430 | -0.086 |
| Gangiri | -2.223 | -1.896 | 1.083 | 0.722 | -0.505 | -1.898 | -0.261 | -0.814 | -1.382 | -1.158 | 1.964 | -0.310 | -1.708 | -1.296 | 2.520 | 1.530 | -0.560 | 0.342 | 0.609 | -1.201 | -0.561 | 0.564 | -0.293 |

Source: Computed by Researcher data obtained form Directorate of Agricultural Statistics, Aligarh

## APPENDIX III

Standard Scores of Variables of Agricultural Development in Selected Villages of Aligarh District (2016)

| Villa | $\mathrm{X}_{1}$ | $\mathrm{X}_{2}$ | $\mathrm{X}_{3}$ | $\mathrm{X}_{4}$ | $\mathrm{X}_{5}$ | $\mathrm{X}_{6}$ | $\mathrm{X}_{7}$ | $\mathrm{X}_{8}$ | X ${ }_{9}$ | $\mathrm{X}_{10}$ | $\mathrm{X}_{11}$ | $\mathrm{X}_{12}$ | $\mathrm{X}_{13}$ | $\mathrm{X}_{14}$ | $\mathrm{X}_{15}$ | 16 | $\mathrm{X}_{17}$ | 18 | , | X | CSS |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1.Ta | 1.047 | 0.894 | 1.161 | 0.466 | 0.271 | 1.040 | 0.302 | -0.282 | 0.502 | 1.336 | -1.523 | -0.014 | 0.611 | -0.668 | -0.456 | 2.803 | -0.321 | -0.246 | 1.418 | 0.757 | 0.455 |
| 2.Hetalpur | 1.276 | -0.002 | 1.398 | -0.855 | 0.754 | 1.266 | 0.251 | -0.066 | 0.575 | -0.700 | 0.648 | -0.562 | 0.070 | -0.375 | 1.511 | -0.429 | 2.409 | -0.544 | -0.966 | 0.366 | 0.301 |
| 3.Elampura | -0.849 | -1.172 | -0.798 | -0.840 | -1.051 | -1.185 | -1.229 | -0.732 | 0.398 | -0.793 | -0.169 | -0.562 | 0.306 | 0.657 | 0.684 | -0.429 | -0.509 | 0.482 | -0.006 | 0.359 | -0.372 |
| 4. | -0.376 | -0.224 | -0.593 | 0.062 | -1.051 | -0.362 | -0.536 | -0.655 | -1.994 | -0.993 | -0.350 | 0.381 | 0.695 | -0.269 | 0.718 | -0.429 | -0.434 | -0.656 | -1.649 | -0.295 | 51 |
| 5.Ainchana | 0.890 | 0.695 | 0.999 | 1.209 | 1.019 | 0.886 | 0.139 | 1.050 | 1.092 | 0.852 | 0.233 | 0.4 | 1.3 | 0.210 | 1.511 | -0.429 | 0.665 | 0.071 | 2.019 | 1.645 | 0.826 |
| 6.Kasison | 0.047 | -0.058 | 0.128 | 0.368 | -0.424 | 0.055 | -0.37 | -0.22 | 0.180 | -0.688 | 0.351 | -0.562 | -0.996 | -0.527 | 0.369 | 1.645 | -0.376 | 0.877 | -0.220 | -0.402 | -0.042 |
| 7.Tej | -0. | -0.5 | -0.623 | 0.035 | 0. | -0. | -0. | -1. | -1 | -0 | -0 | -0 | 0 | -0 | 5 | -0.430 | 1 | 0.545 | 9 | 9 | 2 |
| 8.Faridp | -0.791 | -0.695 | -0.738 | -0.612 | -1.051 | -0.770 | -0.802 | -1.291 | 0.045 | 1.366 | -0.106 | -0.562 | -1.142 | -0.922 | -0.748 | -0.429 | $-1.581$ | 1.051 | -0.499 | -0.689 | -0.548 |
| 9.Luosara Bisawan | -0.946 | -0.871 | -0.898 | -0.549 | -1.051 | -0.923 | -1.181 | -0.665 | 0.295 | -0.545 | 0.601 | -0.562 | -2.335 | -0.656 | 0.435 | -0.429 | -0.638 | -1.011 | -0.142 | -0.322 | -0.620 |
| 10.Kaithwa | -0.58 | -0.46 | -0.72 | -0.6 | -0 | -0 | -0 | -0 | 0. | 0. | -0 | -0 | -0 | -0 | 0.382 | 9 | -0.026 | 1.181 | 6 | 2 | -0.205 |
| 11.Boner | -0. | 0.005 | -0.10 | -0 | 0. | -0 | 0.02 | -1.08 | 0. | 0. | -0 | -0 | -0 | 0 | -0 | -0 | 0. | -0.634 | 8 | 0.880 | 16 |
| 12.Pikhlaun | -0.249 | -0.080 | -0.631 | -0.635 | -0.386 | -0.092 | -0.105 | -1. | 0.481 | 0.139 | -0.890 | -0.562 | 0.580 | 1.259 | 0.571 | -0.429 | 1.467 | 1.047 | 0.363 | 1.085 | 0.082 |
| 13 | 1.9 | 1.727 | 1.469 | 1.767 | 0.860 | 1.88 | -0.83 | -0.210 | 0.430 | 1.716 | -1.329 | 3.161 | 1.325 | -0.730 | -0.773 | 1.691 | 1.066 | -0.835 | 0.527 | 1.389 | 0.810 |
| 14.Khurrampu | 1.7 | 2.232 | 1.9 | 2.0 | 0.5 | 1. | -0. | 0.3 | 0.3 | 2. | -1 | -0 | 0. | -0 | -0 | -0 | 0. | -0 | 0.921 | 1.050 | 0.627 |
| 15.Pilkhuni | 0.131 | -0.043 | 0.215 | -0.676 | 0.527 | 0.13 | 3.03 | 1.1 | 0.367 | -0.61 | 2.26 | -0.56 | 0.62 | -0.52 | 0.848 | -0.429 | $-1.121$ | -1.639 | -0.883 | -1.785 | 9 |
| 16.Go | 0. | 0.672 | 0.508 | 1.307 | 2. | 0. | 1. | 1.398 | 0.284 | -0.779 | 0.91 | 0.582 | 1.355 | -0.726 | 1.406 | 2.429 | 0.527 | -0.952 | -0.142 | 0.657 | 0.696 |
| 17. | -0.03 | 0.167 | 0.0 | -0.022 | 0.42 | -0.0 | 1.02 | 1.706 | -1. | -0.993 | 0.365 | -0.562 | -1.447 | -0.861 | -0.242 | -0.429 | -0.668 | -1.209 | 0.233 | -1.657 | -0.293 |
| 18.Alipur | -0.525 | -0.393 | -0.463 | -0.467 | -1.051 | -0.508 | 0.083 | 0.760 | -1.719 | -0.830 | -0.244 | -0.562 | 0.053 | -0.810 | -1.523 | -0.429 | -1.392 | -1.215 | -0.604 | -1.371 | -0.660 |
| 19.Makhdum Nagar | -1.409 | -1.395 | -1.376 | -0.705 | -1.051 | -1.379 | -0.93 | -0.605 | -1.844 | -0.747 | 0.027 | -0.562 | -1.684 | 2.146 | -2.636 | -0.429 | -0.347 | 0.223 | -0.006 | -0.520 | -0.762 |
| 20.Rahmapur | -1.10 | -1.053 | -1.06 | -0.783 | -1.05 | -1.082 | -0.81 | -0.372 | -0.193 | -0.335 | -0.447 | -0.562 | -0.198 | 0.122 | 0.529 | -0.429 | -0.859 | 1.783 | -1.278 | -0.270 | -0.473 |
| 21.Ektajpur | -1.094 | -1.039 | -1.051 | -1.285 | -0.443 | -1.069 | 0.198 | 0.153 | 1.042 | 1.224 | -1.732 | 1.540 | 0.997 | 2.967 | 0.184 | -0.429 | 0.568 | 1.592 | 0.233 | 1.498 | 0.203 |
| 22.Gidaura | -1.091 | -1.035 | -1.047 | -1.212 | -1.051 | -1.066 | 0.242 | -0.050 | 0.606 | -0.771 | 0.439 | -0.562 | 0.122 | 0.029 | -0.120 | -0.429 | 0.092 | 0.278 | -0.006 | -0.182 | -0.341 |
| 23.Taharpur | 1.650 | 2.073 | 1.784 | 1.907 | 1.941 | 1.635 | 1.577 | 2.599 | 0.834 | -0.993 | 1.738 | 0.419 | -0.791 | 0.472 | -0.624 | -0.429 | 0.953 | -1.201 | 0.979 | 0.832 | 0.868 |
| 24.Kaimawali | 0.759 | 0.629 | 0.468 | 0.646 | 0.686 | 0.756 | 0.901 | 0.182 | 1.052 | 0.273 | 1.428 | 2.231 | 0.393 | 0.987 | 0.327 | -0.429 | 0.323 | 1.170 | 2.184 | 0.318 | 0.764 |

Source: Computed by Researcher based on data obtained from field survey, 2016

## GLOSSARY

Arhar- pigeon pea
Barseem- most important leguminous forages to feed the animals
Doab- region lying between two rivers
Jamun- Indian blackberry or Syzygium jamblanum
Khadar- New alluvium of the Ganga plain
Kharif- crops grown during summer season
Masur- lentil
Moong- green gram
Rabi- crops grown during winter season
Tehsil- administrative division of a district
Urad- black gram
Zaid- crops grown between kharif and rabi crop season

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[^0]:    Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011

[^1]:    Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011

[^2]:    Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011

[^3]:    Source: Computed by Researcher on the basis of Landsat 5 data 1996 and 2011

[^4]:    Source: Computed by Researcher based on table 4.10

[^5]:    Source: Computed by Researcher based on table 4.16

[^6]:    Source: Computed by Researcher based on table 4.20

[^7]:    Source: Computed by Researcher

[^8]:    Source: Computed by Researcher based on table 6.8

