ROLE OF MODERN TECHNOLOGY IN TRANSFORMATION OF AGRICULTURE IN LOWER GANGLA YAMUNA DOAB

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IN
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BY
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( NAJEEB WAIJ AMMAR )
INTRODUCTION

Agriculture is the most important occupation and the mainstay of the population of India which dates back to the time of Indus valley civilization. About 75 percent of the Indian population lives in big and small villages scattered all over the country and carries out agricultural and allied activities.

The importance of agriculture has been further identified by the fact that the population growth of the country is increasing very fast exerting a great pressure on land which affects man-land ratio. This crowd on agricultural land adversely affect the ecology of the area. Thus the land should be used with great care and thought, and agriculture has to be evolved, taking into consideration all the environmental and socio-economic factors.

Agricultural transformation implies the rational use of land resource through applying a higher degree of modern inputs. The agricultural transformation and its development should be such that it should provide not only the balanced and adequate diet to the entire population, but also the raw materials to the agro-based industries.
The area under review is that of lower Ganga-Yamuna doab which is a very clearly geographical defined region lies between 25° 16′N and 27° 00′N latitudes and 79° 30′ and 81° 55′E longitudes. In the north it is bounded by river Ganga and in south by river Yamuna. It is a flat alluvial plain having very gentle slope towards southeast. The flat plain with rich soil led to the even distribution of settlement throughout the region.

Agriculture in India has undergone a considerable transformation during the last two decades. This change is discernible in its both qualitative and quantitative aspects. Qualitatively it shows an increased trend from subsistence towards commercial farming and from diversification towards specialisation. Quantitatively there is observed a high increase in crop output bringing the country to the self-sufficiency in food production. However, the most significant change in Indian agriculture is a change of technology. It shows a shift away from traditional and inflexible technology towards modern and high-energy technology. This shift in technology in association with the shift in institutional set up have made possible to initiate Green Revolution in the country.

The effect of green revolution though felt throughout the country, is more discernible in some
LOCATION MAP
OF
LOWER GANGA-YAMUNA DOAB
IN
UTTAR PRADESH

scale in kilometres

1 Cm = 18.5 Km
areas while in most ports it is negligible. Geographically speaking, the green revolution is actually materialized in the north-western part of the country comprising the states of Punjab, Haryana and western Uttar Pradesh. However, process of diffusion of new technology and institutional components is in progress although with a varying degree of agricultural transformation throughout the country. The most tangible expression of spatial variation is observed in the case of agricultural productivity. This state of situation is of considerable interest for geographical investigations.

The present work is an examination based on conceptual and methodological analysis to understand the agricultural productivity and its technological and institutional correlates.

In the present work the author has made an attempt to study the problems related with the role of modern technology in agricultural transformation. A tehsilwise data of various modern agricultural inputs and the yield of major crops of the study region have been worked out for the year 1982-83. The data has been collected from the office of the Directorate of Agricultural Statistics, Uttar Pradesh, Lucknow. Kendall's simple technique of ranking coefficient has been used to determine
the input and output efficiency. These ranking coefficients of input and output have been correlated and it is found that all the tehsils of the region are not uniformly transformed.

The whole work is divided into five chapters. First chapter deals with the general physical characteristics of the region. In this chapter, geological formation of the doab, climatic conditions, soils and drainage system have been studied. The climate of the doab is characterised by a rhythm of seasons which is produced by the southwest and north east monsoons. The dry season lasts from November to the middle of June and can be further divided into two seasons: cold weather season and hot weather season. The cold weather season extends from November to February while the hot weather season last from March to middle of June. The wet season extends from the middle of June to the middle of October. These seasons and the related temperature and rainfall conditions have been investigated.

Rainfall as an element of climate is most important from the agricultural point of view. The distribution of rainfall in the lower doab has also been studied.
The analysis of soils of the region reveals that there are two soil types - the new alluvium or khadar and old alluvium or Bhangar. The Bhangar, which covers a large area of the region varies in accordance with the topography and drainage.

Second chapter deals with the conceptual frame work. In this chapter, the three dimensions of agricultural development, i.e., productivity, diversification and commercialisation of crops have been studied in relation to its ecosystem.

Third chapter deals with the study technological and institutional factors influencing over agricultural transformation. A profound change in some regions of Indian Agriculture has been marked by 1960. It was in fact had been brought out by the H.Y.V. technology which was adopted by farmers with the introduction of new agricultural strategy. With the spurt of this new technology, Indian Agriculture experienced a quick-yielding change in the field of food production leading to the so-called green revolution. As a result, a new dimension of hope associated with the challenges was opened up due to the adoption of new farm technology, modern and practices.
The new agricultural strategy, with emphasis on the use of tractors, threshers, chemical fertilizers, irrigation and H.Y.V seeds etc., have a built-in bias towards the promotion of inequalities and poverty galore. This bias gets built into new agricultural strategy because of the very agrarian structure of production relations in which it is adopted. The agrarian structure of production relations existing in rural India makes the use of new farm technology more favourable and beneficial to those farmers who own and operate a large size of holding than to the farmers owning and operating a small or marginal size of holding because of the following:

a) they have greater control over the supply of scarce agricultural resources;

b) they have greater access to credit with their greater 'credit-worthiness'; and

c) they possess greater 'technical dynamism.'

The small and marginal farmers having insignificant degree of control over the supply of agricultural resources and 'credit worthiness' find difficulty in competing with large farmers. As a result, the process of converting some of them as landless agricultural labour operates
leading to increase in the number of agricultural labourers. Thus the adoption of new technology in the present agrarian structure, has created more weaker section than what anticipated in view of attaining the goal of growth with justice in agriculture. To minimise the inequality in rural society of India in general and in the study region in particular, more emphasis should be given on minor irrigation facilities, small farm machineries and organic manures so that small and marginal farmers could be benifited.

The modern agricultural research designed to produce and continuously improve an economically viable and ecologically adaptable technology represents a critical missing link in the agricultural development process in India. The agricultural research should be highly location specific. In order to produce viable results it must be conducted in an environment in which both ecological and socio-economic conditions approximate those where the innovation will be employed.

In agricultural transformation, irrigation plays a vital role. The nation has become aware of this acute problem and crores of rupees are being spent on irrigation projects for the last 35 years of planned development.
However the problem is yet to be solved. Minor irrigation should be given priority keeping in view the needs of small and marginal farmers.

Second part of this chapter deals with the institutional changes in which land reform is the most important. The idea of land reform arise out of the political ideologies and effect people and production. Land reform in the traditional sense of the term, means the redistribution of land ownership for the benefit of small farmers and landless agricultural labourers. In its wider sense it encompasses agricultural economic institutions generally, including agricultural land ownership and tenancy, land rent, taxation of agricultural land and rural credit facilities.

Chapter fourth deals with the review of work done so far. In this chapter comprehensive account of work done so far have been studied. And lastly is the chapter fifth which deals with the methodology of the work. Here few statistical techniques have been suggested for the proposed research work. Out of several techniques, Kendall's simple technique of ranking coefficient have been used to determine the input and output efficiency so that the lower the coefficient the higher the efficiency. These ranking coefficient of input and output have been corelated and it is found that all the tehsils of the region are not uniformly transformed.
CHAPTER - I
GENERAL GEOGRAPHICAL CHARACTERISTICS OF LOWER GANGA-YAMUNA DOAB

Structure and Relief

The region which stretch from northwest to southeast occupy mostly the lower portion of the Ganga-Yamuna Doab. The region is sloping down towards southeast. In the northwest portion the region is broader and it is tapering down towards southeast. The area of the region fluctuates from year to year due to the changing course of the rivers Ganga and Yamuna, but the loss at one place is, more or less, compensated by the gain at the other. The plain come into existence during the recent geological period. It is made of alluvial deposits brought down by the rivers from the Himalayan in the north and from Vindhyans in the south.

There are differences in the opinion regarding the evolution of this region. According to Burrard, the origin of this depression is similar to that of the great valley of Africa.¹ Burrard gave the same age to this region also. According to him the plain occupied a deep rift valley bounded by parallel faults on its two sides with a maximum downthrow of 32 kilometres and the valley was subsequently

filled up by detrital deposits. This hypothesis has few geological facts in its support and does not confirm with geological observations. But according to Edward Suess, an eminent Austrian Geologist, the plain was a 'fore-deep' between the Himalayas in the north and peninsular India in the south. The rivers from the Himalayas brought tremendous amounts of detritus, and filled up the depression. The process led to the formation of this plain.

The third and more recent view on the origin of this region is a 'Sag' in the crust formed between the northward drifting Indian continent in the south and the comparatively softer sediment-accumulation in the sea of Tythes as well as in the surrounding basins in the north. As the sediments in the sea of Tythes were being crumbled and lifted into a mountain system, the rivers were filling this 'Sag' and finally the plain came into existence.

Upto this stage it can be well concluded that the depression began to form in the upper Eocene and attained its greatest development during third upheaval in the Middle

2. Wadia, D.N. & Auden, J.B., Geology and Structure of Northern India, Memories of Geological Survey of India, Vol.73, (Delhi, 1939), P.134.


Miocene. Since then it has been gradually filled up by the sediments to form the level plain sloping gently towards the sea.  

There are different opinions as far as the thickness of the alluvium is concerned. The deepest boring that was carried on in Uttar Pradesh is at Lucknow. Although the boring is 407 meters deep, the rock bottom has not yet been touched. The Geodetic data obtained by the survey of India in Bihar estimates the thickness of the deposits in the basin as 1800 meters. In Aeromagnetic survey of the delta of the river Ganga in Bengal indicates that the basement rock lie at a depth of about 5,181 meters to 6,096 meters. On the basis of the geodetic data, Oldham believes that the Gangetic trough reaches a depth of 457 to 6,096 meters towards its northern edge and that its floor has a fairly regular upward slope towards the southern edge. By using the gravity results of different stations in the plain, E.A. Glennic calculates the depth of the alluvium as 1,981 meters. Although this figure confirms with geodetic data, it does not confirm with geological facts. 

using the same data, adopted even higher figures.

In the districts of Kanpur, Fatehpur and Allahabad, the alluvial deposits consists mainly of clay, silt and sand with some time gravel beds. Geologically the region may be divided into two broad divisions, i.e., the older alluvium called *bhanger* and the newer alluvium known as *Khadar*. As far as the age is concern these deposits correspond with two main divisions of Quarternary Era: the Pleistocene and Recent. They have been distinguished on the basis that the land occurring at higher levels and which is not inundated by rivers during rains, has been called *bhanger* whereas the land stretching along the river basin and is, occasionally, flooded during the monsoon season has been named *Khadar*.

The bhanger land is generally a leveled plain above the flood level of the main rivers and its tributaries. It is dark in colour and is, generally rich in concretion and nodule of impure calcium carbonate locally known as *Kankar*. Kankar varies in shape and size. In size they range from small grains to lumps of fairly big size. Generally the level of bhanger is 8 to 17 meters above the lowest level of the river Ganga.

The Kankar nodules are formed due to the segregation of the calcareous material of the alluvial deposits into lumps nodules, somewhat like the formation of flint in the
lime stone. The Kankars are used for the construction of the metalled roads. Medlicott suggests that the Kankar nodules and the calcareous beds have been deposited from the water containing solution of carbonate of lime derived from the older rocks of various kind or else from fragments of limestone contained in the alluvium.

Bhangar land has some alkaline and saline patches which have formed due to the very gentle slope of the land and faulty composition of the alluvium. The average slope in the bhangar land is one meter in five kilometer (1:5000) which results in very sluggish movement of ground water as well as a slow movement of surface water. During the rainy season, the water, percolating downwards, dissolve the soluble salts accumulated in the sub-soil by percolation. The salts are brought back to the surface by capillary action during the summer month, forming patches of white efflorescence. Alkaline formation may be expressed by the fact that the dominant constituent of the old alluvium is clay and sodium clay which reacting with Kankar nodules is turned into calcium clay and liberates sodium carbonate.

The Khadar land is limited to flood plain of the river and is liable to inundation during floods. Khadar land

occupies lower level. The lower level of Khadar is in conformity with the general principle that the river becomes older in time, its deposits become progressively younger and if the bed of the river is continuously sinking lower, the later deposits occupy a lower position along its basin. Khadar land is light in colour and poor in calcareous matter and correspond in age with upper Pleistocene and Recent. It is generally composed of sands, gravel and peat.

DRAINAGE

The drainage of the lower Ganga-Yamuna doab region discharges itself into the river Ganga. The courses of the rivers and their tributaries generally follow the slope of the area. A number of perennial and seasonal rivers flow in this area from northwest to southeast. The main rivers of this region are Ganga, Yamuna, Rind, Sasur Khaderi, Barauna, Non, Panchu, and Kilnahi. Only Ganga and Yamuna rivers are snow fed and are flowing through out the year. The rest of the rivers are small and are seasonal in character. These seasonal rivers have their origin from lakes and tals. The flow of these seasonal rivers varies from summer to rainy season. In summer these rivers are almost dry and in the rainy season these rivers has very great discharge of water.
LOWER GANGA YAMUNA DOAB DRAINAGE

SOURCE: SURVEY OF INDIA
SHEETS NUMBER
53(F,G,H,J,K,L)
54(E,I,M,N)
63(B,C,G)
The region under study form the drainage basin of river Ganga which recieves most of the other rivers of this region as its tributaries. This river form the northern boundary throughout the whole length of the region. At the border of Kanpur and Fatehpur in the west, it is joined by the river Pandu from south which is its only affluent of some importance. For about 38 kilometers it forms the northwestern boundary of the Allahabad district after which it enters the district seperating tehsil soraon and Phulpur from chail after which it joins the river Yamuna at the eastern most limit of the Ganga-Yamuna doab region. The course of the river Ganga is a succession of large bends and loops throughout its course. Before meeting with river Yamuna, it takes a bold sweep to the northeast, then it bends sharply towards south and joins with the river Yamuna near the Fort of Allahabad.

In the north eastern region, the physical character of the area is greatly determined by the river Ganga which flows throughout a well defined broad bed. Upto the western half of Fatehpur, the ground slopes towards the river whereas in the rest of the region, before its confluence it slopes towards the centre. Its water-shed in Fatehpur closely follows the Fatehpur branch of the lower Ganga canal upto Jalala after which it varies in breath from
3 to 8 kilometers. Due to the fluvial action of the river, it is constantly shifting its channel and it seldom retains the same course for two years. In some places the river flows closely to the high banks and more often there is a broad expanse of alluvium which is subjected to constant changes. The river fluctuates from year to year but the lose of land at one place is compensated by the gain of land at other place. During the rainy season the Ganga is magnificent body of water of immense depth with an average breadth of about 3 to 5 kilometers. In winters and summers, the river shrinks to a comparatively smaller dimension and often break up into two or more channels.

**RIVER YAMUNA**

The river Yamuna forms the entire boundary of the southern limit of the lower Ganga-Yamuna doab region. The river has a very tortuous course with its bed, on an average, 15 meters deeper than that of Ganga. It has a gradient of about 1:1300. The average width is about 2.5 kilometers during the flood and in dry season it is only about one kilometer wide.

In its earlier course, before the confluence of the river Rind, it flows from west to east. After the confluence
of the river Rind the course of the Yamuna river is very circuitous bending at many places at right angles and sometimes flowing in an entirely opposite direction to its normal course. Inspite of its circuitous course, it does not change its course altogether but it fluctuates from year to year. This change is almost negligible.

The river Yamuna has a narrower valley, more constant channels, and steeper banks than river Ganga. The cliffs rise at places to great heights, for example, just at the point where the river Yamuna touches the Allahabad district, the fall from upland to the river bed is not less than 33.5 meters. Elsewhere it is between 10 to 15 meters. The bank of the river is generally very steep for greater part of its course and are scoured with ravines.

The southwestern part of the Fatehpur district is traversed by rivers Rind and Non, beside the river Yamuna. Near the banks of these rivers there are extensive ravines. Further eastward where Yamuna is supposed to have receded south giving way to great accumulation of silt and making the area highly productive and produces crops like wheat and rice without irrigation.

THE SASUR KHADERI

This river rises on the southern slope of the Ganga watershed near Muniuddinpur which is nearly 20 kilometer
northeast of Fatehpur. More or less it flows from northwest to southeast and joins the river Yamuna.

In its upper course, the river Sasur Khaderi is no more than a chain of swamps. Later on, it issues as an overflow of Ghuri Jhil where the course is very ill-defined because much of the rain water is absorbed by lakes. Only in unusually wet years, the water passes down the river with the result that only after Kulharia village the river assumes a definite bed even if it is only between 5 to 10 meters wide. Near Allahabad border, its bed is considerably broad but in its upper course the shallow channels looks to have been filled up with silt and therefore, constantly increasing proportion of water from the neighbourhood of Saunt which is transferred to a tributary of Baraun river when it enters Sirathu tehsil, it has a well defined bed with a tortuous southeasterly course in the mid lower doab. Except in the Southeast, the river in the rest of Sirathu tehsil flows on level with the surrounding land with barren stretches. The banks are covered with 'dhak' jungles but lower down where it forms the boudary of Manjhanpur tehsil, the channel becomes deeper and the banks are broken by ravines which make the land agriculturally unproductive. Just before the Sasur-Khaderi enters the chail tehsil, it is joined by Chhoti Kilnahi river from the south beyond which the broken bank
of sasur khaderi river become fringed with innumerable drainage channels and ravines which become deeper and more extensive as the stream approaches its outfall. This river has sufficient water during monsoon months. In the months of winter it is almost dry but the bed is always moist and in many places full of dangerous quick sands specially at its confluence with Yamuna river.

THE KILNAHI

The source of river Kilnahi is in Shah Alam lake which is situated near 8 kilometers south west of Manjhanpur tehsil. In its upper course it flows southeast but near Bajha Khurrampur, it is crossed by Dhata distributary where it turns south and enters the southwest corner of Chail tehsil. Here the bed become deeper and the banks are scoured by numerous ravines. Before meeting Yamuna, it met with few smaller rivers from the west. The river is perennial except for a few kilometers in its upper course.

THE BARAUNA

The river Barauna has its origin in the southern slopes of the Ganga watershed in Mahasha and other jhils, a few kilometers northeast of Hindki. It is locally known as Mahanad, Hilanda Nadi, Bari Nadi etc. at different places. This
river is the continuation of shallow swamps in its upper course. It is because the slope of the area is very low and it is difficult for the river to flow. This results in the formation of swamps. This swampy area is devoted to paddy cultivation. The total length of the river is about 110 kilometers. The river in the northern and central parts is no more than a chain of swamps and lakes. As the river proceeds further, the bed deepens producing ravines which cut their way through before falling in Yamuna. This river is of no great significance but it controls the greater portion of the drainage system of the mid lower Ganga Yamuna doab.

THE RIND

This river is a tributary of river Yamuna. It rises near Aligarh. After flowing through the districts of Etah, Mainpuri, Farrukhabad, Etawah, it enters Kanpur. This river has perennial character. The volume of the water in the river increases due to some canal escapes. The region which is on the west of this river is inaccessible during rains. The river has a very irregular course but it flows in southeast direction. It has considerable width. It flows southwards before it joins river Yamuna at Fatehpur. There are several water courses which cut their way through hard calcareous soil before the river joins Yamuna. It results in a network of
deep ravines covered with scrubs and except for the bed of the river itself and larger ravines, there are very little cultivated tracts.

THE NON

The river Non rises in Kanpur district. It enters in Fatehpur district in the extreme southwest of Khajua tehsil. This river flows over a very small area, but it flows in a tortuous course towards southeast. After flowing far about only 15 kilometers in Fatehpur district it joins river Yamuna in the south of Chandpur. It has a deep and well defined bed but on either sides, like other rivers, it flows through ravines. It contained water all the year round.

THE PANDU

This river also rises in the district of Kanpur. It enters in Fatehpur in the northwest at Parasdepur. When it enters in Fatehpur, it has a southerly course but just after 5 kilometers, it flows northeast and making a boundary between Fatehpur and Kanpur for a few kilometers, then it flows eastwards and joins the river Ganga near Sheorajpur. River Pandu is the only tributary of Ganga river of some importance in this region. It flows in a very peculiar course piercing through the high ridge before it joins with the river Ganga.
The region of lower Ganga-Yamuna Doab, which is under study is situated between 25° 16'N to 27° 00'N lat. & between 79° 30'E to 81° 55'E longitude lies in the subtropical monsoon type of climatic belt. This type of climate has a seasonal change due to the occurrence of southwest and northeast monsoon. The word monsoon has been originated from an Arabic word 'mausim' which means season. This word implies for the seasonal change of the air current which is reversed from winter to summer. The direction of the wind is reversed twice in a year with a direction from northwest to southeast in the Northeast monsoon season and from southeast to north east in the southwest monsoon season.

The southwest monsoon season extend from Mid June to the end of October has a humid wind of oceanic origin with its main characteristics as cloudy weather, heavy rainfall and high relative humidity. The rest of the year has, generally dry wind of continental origin, marked by extremes of temperature, cloudless sky, and very low humidity. Considering the nature of the wind, the term dry monsoon and wet monsoon seems most appropriate.

The dry monsoon period may be sub-divided into two: the cold weather season extending from November to February and the hot weather season from March to Middle June.

The Indian Meteorological Department has divided a year into four seasons and these four seasons are (i) the cold weather season from December to end of February (ii) the hot weather season from March to middle of June, (iii) the rainy season from middle of June to the end of September and (iv) the season of retreating monsoon from October to end of November. But for a smaller region under study such as lower Ganga-Yamuna Doab which consists the districts of Kanpur Fatehpur and parts of Allahabad it would be better to divide the year as follows:

i) The cold weather season (Nov to Feb.)
ii) The hot weather season (March to mid June)
iii) The rainy season (Mid June to October)

The cold weather season corresponds with the Rabi crops where as the rainy season correspond with the Kharif crops.

i) The cold weather season:

With the southward movement of sun, the southwest monsoon retreat, generally by the last of October and
the area gradually develops into a high pressure region due to the gradual fall in temperature. The prevailing eastward direction of the wind is determined, partly by the pressure distribution and partly by the trend of Himalayan relief. ¹²

The approach of the cold weather season is marked by the considerable fall in temperature. The cloud free skies in the daytime permit free insolation and in the night, rapid radiation takes place which result in cool night and comparatively warm day. The mean monthly temperature in November at the lower Ganga-Yamuna doab region is 21.5°C. The mean maximum temperature of the region in November is 29.5°C and the mean minimum temperature of the region for the same month is 12.6°C. In the month of December the temperature further decreases by about 4.2°C, the days become less warm and the night colder. The lowest temperature of the year is recorded in January, which is the coldest month and the mean monthly temperature at this region is recorded as 16.0°C. The month of December and January experience frosts but they are not so severe to damage the crops. During these months, fog or mist, which

¹² Mean Pressure and Prevailing winds; Climatological Atlas for Airmen (Roona, 1943), P. 43.
is locally known as 'Kohra' is experienced in the night which disappears, usually, in the day light.

During this season, the winds are of continental origin and therefore they are dry. Besides some rainfall due to the cold weather storms, this season is largely without rain. The cold weather season has bright sunny weather with clear skies, low temperature and low humidity.

Hailstorms are not uncommon during the cold weather season. According to Dr. Buist, the hailstorm in the plains of Uttar Pradesh seldom last for more than 15 to 20 minutes but they occur simultaneously at places remote from each other in long narrow belt. The area affected by hailstorm is small. The effects are very much localized. One field may be affected while the other a few metres away, many remain almost untouched.

Except for an increase in temperature by the end of February, there is little change in the weather as a whole. With the northward movement of the sun, the hot weather season approaches and the temperature starts rising rapidly by the end of this month.

ii) The Hot Weather Season:

With the beginning of March the sun migrates northwards and the hot weather season begins. This season continues till the middle of June when the temperature rises
abruptly. The atmospheric pressure falls over the heated land but the subtropical anticyclonic cell persists. The relative humidity also decreases with the rising temperature. The mean maximum monthly temperature in March at the region is 32.9°C while the mean minimum monthly temperature for the same month is about 15.7°C. The diurnal range of temperature is fairly high, i.e., 17°C to 17.5°C. As a result of high diurnal range, the cool and pleasant nights and warm days are experienced.

In the month of April and May, the sun is almost vertical with the result that the temperature continue to rise. The mean maximum monthly temperature in April at the region becomes about 38.2°C and the mean minimum temperature for the same month is 21.1°C. Although the diurnal range of temperature is high, the days are hot while the nights are warm. The rainfall is little in amount.

As the season advances, there is further increase in temperature and the month of May records the highest temperature of the year. The mean monthly temperature for May is 34.3°C. The mean maximum and minimum temperature are 41.7°C and 26.9°C respectively.

The mean diurnal range of temperature is lesser than that in the month of April. The heat is excessive.

in the day. The land is parched and bare under a torrid sum.

In the month of June, the temperature starts falling slowly. The relative humidity increases. The increase in humidity with increase in temperature makes the heat in June unbearable.

In the summer month, dry westerly winds locally known as 'LOO' is a regular phenomena. The intensity of loo is greater in May and early June.

The movement of the wind in this season during night time is feeble. The movement of wind increases from 8 a.m. and when conditions are more favourable, they move with a force of gale. In the evening by 6 p.m. it stops. The table below shows the ground surface temperature as well as temperature at 4 feet above the ground at Allahabad.

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean temp. in (°C) of ground surface</th>
<th>Mean temp. in (°C) at 4 feet above the ground surface</th>
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<tbody>
<tr>
<td>March</td>
<td>48.77</td>
<td>32.44</td>
</tr>
<tr>
<td>April</td>
<td>57.61</td>
<td>29.33</td>
</tr>
<tr>
<td>May</td>
<td>61.55</td>
<td>43.05</td>
</tr>
<tr>
<td>June</td>
<td>52.33</td>
<td>37.44</td>
</tr>
</tbody>
</table>

MEAN MAXIMUM AND MEAN MINIMUM TEMPERATURE

ALLAHABAD

FATEHPUR

SOURCE: ON THE BASIS OF DATA SHOWING NORMALS, OBTAINED FROM THE METEOROLOGICAL DEPARTMENT, NEW DELHI
It clearly shows that near the surface of the earth the conditions are not conductive for a state of stable equilibrium and hence convective air movement are resulted.

Great dryness and high temperature are the most important feature of these westerly wind. The occurrence of duststorm in the evening locally known as 'Andhi' is the other important phenomena of this season. Due to this andhi the visibility become poor. These duststorms are often associated with cumulus and cumulonimbus clouds and are accompanied by powerful squalls of short duration. The velocity of these squalls may be as high as 65 kms per hour which is strong enough to blow off thatched roofs and trees. These momentary duststorms end up in light showers and some times accompanied by hail and thunderstorms.

The rainfall of hotweather season varies with that of cold weather season. It is sporadic, short lived, subject to great local variation and frequently felling about the same hour day after day for many days in succession. The barometric oscillations during the storm are rapid and considerable but are largely due to local causes. Though the amount of rainfall in this season is very little, it gives temporary relief from the intense heat of the day.
iii) **The Rainy Season:**

The high temperature of the hot weather season causes the development of low pressure area in the northwestern India. Therefore by the middle of June a number of sudden changes occur in the weather and a new air mass arrives. The inter-tropical zone of convergence invades the region abruptly and with the arrival of humid oceanic air current, the temperature falls and the air becomes cool and pleasant. The mean temperature of this region in July is $30.09^\circ C$. The air is saturated with water vapour and thick clouds covers the sky. The average cloud cover over the region in August is about 7 to 8.5\( ^{15} \). The relative humidity becomes very high. On account of high cloud proportion, the mean maximum temperature decreases contineously.

The time of the brust of mansoon rain varies from last week of May to the first week July but generally it sets in during the second or third week of June and remain continues till the end of october. The cause of the brust of mansoon is controvercial but its origin is, however, associated with certain basic changes in the general high attitude circulation over south Asia. The month from July


A clear sky is represented by Zero and an entirely overcast sky by 10.
to October receives about 90 percent rainfall of the year. The distribution of rainfall is very uneven in space and time. The reasons of this variation are firstly because of the horizontal expansion of the equatorial air flow which weakens the convergence, secondly due to the relief features.  

The rainfall of summer in this region is the result of interplay of the two main currents of monsoon and their contact adjoining uplands. One of the main current passes the low lands from over the Bay of Bengal and the other crosses the west coast from the Arabian Sea.

Generally the monsoon burst in the second or third week of June, remains steady in July and August and gradually decreases by September. The burst of monsoon is the result of orographic features. According to Yin, the surface thermal depression in the northwest of India has no effect unless it is reinforced aloft by the cyclonic waves caused by the Himalayas. Concentrated spells of heavy rainfall result in flood in rivers during these months. Burst of rain alternating with rainless interval which lasts hardly for few days, fallow in succession in the months of July and August. It results in giving these months rainiest spells throughout the year. All the rainfall recording
stations in the region receives more than 60 percent of the total annual rainfall as shown in the following table.

**TABLE**

Rainfall of July and August with percentages to total rainfall in some of the recording stations in lower Ganga, Yamuna doab.

<table>
<thead>
<tr>
<th>Station</th>
<th>Total annual rainfall in m.m.</th>
<th>Rainfall in July &amp; August in m.m.</th>
<th>Percentage to the total annual rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatehpur</td>
<td>861.9</td>
<td>550.2</td>
<td>63.84</td>
</tr>
<tr>
<td>Khajua</td>
<td>921.8</td>
<td>574.6</td>
<td>62.33</td>
</tr>
<tr>
<td>Khaga</td>
<td>926.8</td>
<td>519.6</td>
<td>62.55</td>
</tr>
<tr>
<td>Chail</td>
<td>945.5</td>
<td>587.6</td>
<td>62.15</td>
</tr>
<tr>
<td>Bamrauli</td>
<td>980.1</td>
<td>600.7</td>
<td>61.31</td>
</tr>
<tr>
<td>Sirathu</td>
<td>974.8</td>
<td>613.1</td>
<td>62.90</td>
</tr>
<tr>
<td>Manjhanpur</td>
<td>895.6</td>
<td>559.3</td>
<td>62.44</td>
</tr>
</tbody>
</table>

Whenever in the wet monsoon season the low pressure trough shifted northwards and remains close to the foot of the Himalayas, the region receives little rainfall because the easterly wind from the Bay of Bengal also shifted to the north of that axis and fail to penetrate as usual
upto the Ganga valley.

This leads to break the summer rainfall which, sometimes in August and September, may last for 15 days. During September the rainfall normally gets slackened and rainless intervals becomes longer. Dry wind prevail during the break in rains, but it is not a regular phenomena.

In the month of September, the mean monthly temperature of the region is about 28.98°C. With the fall in temperature the pressure increases and the monsoonal currents become weaker and are, therefore, unable to traverse the region. The weakening of monsoon currents is a gradual process. The relative humidity becomes 80 percent and clouds amount 51. Low clouds, longer interval between rains, high humidity and high temperature are the general conditions in the month of September.

There is a sharp decrease in the amount of rainfall in this region in the month of September. At Fatehpur in September it is 167.8 millimeters and in October it decreases to 26.7 millimeters. In the month of September the relative humidity and temperature also falls. The low humidity and motionless air brings oppressive conditions
resulting in the out break of a number of seasonal diseases in September and October.

The month of November and December receives lowest rainfall in the entire lower Ganga-Yamuna doab region.

Variability of Rainfall:

Rainfall has an important and dominating role on the agrarian economy. Any serious departure from average rainfall conditions results in dire consequences, even widespread famine. The same is true for the lower Ganga-Yamuna doab region where unfortunately, there are great variations in amount and duration of rainfall. Generally the rainfall decreases from southeast to northwest.

A detailed study of rainfall in the region reveals that the annual variability and annual rainfall generally, have inverse relationship. It means that when the annual rainfall increase the variability decreases. In the extreme south of the region the variability is about 19.00 percent where as in the middle of the region it is about 22.75 percent. It has been found that in particular year the recording station receives rainfall which is much below the average while in the other year the same station receives rainfall which is much above the average rainfall, for
example, in Khajua the amount of rainfall received in 1965 is 561.0 millimeters which is 46.2 percent below the average whereas the amount of rainfall in 1961 at the same station is 1909.0 millimeters which is 84 percent above the average.

Another example is from sirathu. At this station the rainfall received in 1948 is 1675 millimeters which is 78 percent above the normal whereas in 1956 the rainfall is only 425 mm, which is about 55 percent below the normal.

Next example is from Khaga where the rainfall received in 1936 was 1575 millimeters which is about 70 percent above the normal whereas in 1968 the rainfall received at this station was 300 millimeters which is about 65.5 percent below the normal.

There is great variation of rainfall in the wet monsoon months. About 90 percent of the rainfall of the year occurs in the wet monsoon season and good harvest or failure of harvest is the result of rainfall of this season. Therefore from the point of agricultural operation, the study of variability of rainfall of this region is highly important because the increase and decrease of rainfall will not affect agriculture so much as the variation in time of its occurrence, for example, excessive
or deficient rainfall in the month of June delays in the sowing of rabi crops. Both the conditions results in low yield of crops. Deficiency of rainfall in July and August may cause great damage to rice crops. On the other hand if the amount of rainfall is comparatively small but it has regular intervals and last till the end of September, the agricultural productivity can be increased.

**TABLE**

**MEAN MONTHLY VARIABILITY**

<table>
<thead>
<tr>
<th>Station</th>
<th>June % ±</th>
<th>July % ±</th>
<th>August % ±</th>
<th>September % ±</th>
<th>October % ±</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatehpur</td>
<td>65.52</td>
<td>31.31</td>
<td>19.52</td>
<td>35.99</td>
<td>298.00</td>
</tr>
<tr>
<td>Khajua</td>
<td>88.39</td>
<td>46.50</td>
<td>42.48</td>
<td>51.04</td>
<td>363.41</td>
</tr>
<tr>
<td>Khaga</td>
<td>70.47</td>
<td>33.44</td>
<td>20.71</td>
<td>48.29</td>
<td>287.23</td>
</tr>
<tr>
<td>Chail</td>
<td>72.16</td>
<td>29.64</td>
<td>26.61</td>
<td>32.83</td>
<td>170.23</td>
</tr>
<tr>
<td>Bumrauli</td>
<td>67.44</td>
<td>28.67</td>
<td>19.59</td>
<td>32.90</td>
<td>138.26</td>
</tr>
<tr>
<td>Sirathu</td>
<td>73.70</td>
<td>32.94</td>
<td>28.21</td>
<td>49.58</td>
<td>176.12</td>
</tr>
</tbody>
</table>

This table shows that the variability of rainfall is high in the beginning and at the end of this season whereas it is lowest in the middle. In the months of July and August all the stations are characterised by a variability
below 45 percent except Khajua and it falls 19.00 percent at Fatehpur and Bumarauli. There is a marked variation between the variability of August and October, i.e. at Khaga the variability in August is 20.71 percent where as in October it is 287.23 percent and at Fatehpur it is 19.52 percent in August but in October it is 298.00 percent.

The variability increases in the month of September and reaches its maximum in October. In some cases it goes above 200 percent. It is 363.41 percent at Khajua. The main reason of high variability towards the begining and end of mansoon season is primarily because of the variation in the timing of onset and retreat of mansoon.

SOILS

The soil of the lower Ganga-Yamuna doab region is generally of three types.

1. Younger alluvial (Khadar)
2. Older alluvial (Bhangar)
3. Saline and Alkaline type.

1. THE KHADAR (Younger Alluvial)

The younger alluvial are found along the bank of the river Ganga and Yamuna. This soil is the deposited material of these rivers when they are in flood. The texture of khadar soil vary from gravel and sand in the

upper course to the silt and silty clay in the lower courses of the rivers. In the flood seasons successive deposits of river load gradually raises the level of the existing soil. This newly deposited material of the soil is highly productive.

The younger alluvial soil vary greatly in texture and fertility from place to place. For example, the younger alluvial (Khadar) of Ganga is more fertile as compared to the fertility of Yamuna. The breadth of the soil on either side of the river also varies. The tract along Ganga is wider than that of Yamuna.

The colour of the soil is grey to ash-grey. In low rainfall the soil is dry and when the rainfall is heavy, it is leached away.

2. **OLDER ALLUVIAL** (Bhangar)

This type of soil occupies the level plains above the flood levels of the river Ganga and Yamuna. The texture of the soil, range from Sandy loam to silt and stiff clay. Sometimes large amount of impure calcareous matter in the form of nodules is found to various depths.

The older alluvial soils are loamy throughout the region degree of texture. They may be divided into:
a) Sandy loam  
b) Loamy  
c) Clayey loam  

Sandy Loam

This soil is found in the form of small patches in the Ganga-Yamuna interfluve. The texture of the soil is sandy loam to loam and the colour of it varies from brown to raddish brown. The content of silt and loam increases from northwest to southeast. The water holding capacity of the soil is low. The percentage of organic matter is also low. The soil is of sandy and the extensive cultivation has made it deficient in organic matter.

Loamy soil (Dumat)

It is the most fertile of the older alluvial types of soil and occupied a great portion of the well-drained area of bhangar land. Its texture varies from sandy loam to silty clay. The colour of the soil is dark gray and it is rich in organic matter. The soil has high water holding capacity. This soil is homogeneous in character with shallow depression in which the rain water is collected. From the agricultural point of view this soil is very fertile and produces a variety of crops of kharif as well of rabi season.
Clayey loam:

This soil has a comparatively high moisture retaining capacity as compared to loamy soil. The fine particles of the soil from the elevated land are washed out and get deposited in the depressions and thus in these shallow depressions the soil become clayey. This type of soil in the region are generally devoted for the cultivation of transplanted rice. The texture of this ranges from loamy to clayey loam. Some Kankar depositions are found in the lower bed of the soil. The soluble salt content are high and in some cases they are accumulated in the subsoil but these do not exert any remarkable effect on the cultivation of crops.

The colour of this clayey loam soil varies from brownish to yellowish grey. The soil is so tanacious that it can only worked where it is well soaked. In the dry months it becomes very hard.

Classification of Soil on the basis of Fertility:

The farmers of the region adopted another method for the classification of soil, which is based on the location of the land with regard to the village site and the organic matter present in or supplied to the soil.

The lands immediately surrounding the villages are most fertile and productive because it receivers the largest
amount of animal manure and village refuse along with the night soil which are later decomposed into ammonia and other organic matter. Beside this the land gets about 70 to 80% of composite manure which the farmers puts in their fields. This belt of land which is immediately surrounding the villages settlements is called Goind or Bāra and is placed in the 'A' type of soil. The soil of the region further away from thin type receives lesser amount of manures and village refuse due to the increased distance. This type of soil is less fertile and is devoted to single cropping. This soil is placed in 'B' type of the soil in this region. The land that made the outer most limit of the villages are very far away from the village settlements gets very negligible amount of manure and village refuse. The organic matter is least in this soil. This soil is classified as 'C' type of soil. It is least fertile and produces inferior types crops. Thus the village settlements are the centers from which fertility of the soil gradually decreases. The crop with a good return are found near the settlement and those with poor returns, farther away.18.

In lower Ganga-Yamuna doab region the saline and alkaline soil is found in irregular patches. They are often interrupted with patches of fertile lands. Alkaline salts when present in small amount do not leave any harmful effect on the soil but when the quantity of these salts increases beyond a certain limit, they begin to interfere the growth of crops. By physical action, the salts make the pressure of the soil stronger than that of the cells of the roots of plants and with the result instead of water passing from soil to the roots, it passes from the roots to the soil causing crops to wither away.  

On the basis of different salts content present in it the saline and alkaline soil are classified into saline, saline alkali and alkali. Saline soil is also called Reh. During the monsoon months the soluble salts of the earthcrust are washed away. Some of it goes into the sub-soil through percolation while in the dry summer season due to the capillary action the sub-soil water with dissolved salts come on the surface of the soil. The water evaporates leaving behind the soluble salts in the form of white efflorescence. The saline alkaline soil is also known as USAR.

The usar reclamation committee of Uttar Pradesh suggested that the alkaline conditions of the soil are mainly due to the presence of Sodium carbonate and sodium bicarbonate to the

19. Howard, H. Crop production in India (London, 1924), P.44
extent of 0.1 to 0.4%. The reclamation of usar land is largely a physical problem.

The main work in the reclamation of usar land is to remove the excess of salts from the soil. Soil scientists have made investigations and have suggested three methods of reclamation. The first method is mechanical. In this method the heavy application of water is done so that the deposited salts are washed away. The second method for the reclamation is to use of organic manure and growth of suitable crops in rotation. In the third method some chemical substances like calcium chloride or gypsum are used.

The formation of usar land is due to the imperfect drainage both on surface and underground. Therefore an adequate drainage is the first condition in the reclamation of usar land. This can be done by dividing the usar lands into small blocks with a substantial embankment around them so that they can hold water. Then in these field frequent ploughing should be done so that the salts may be leached out to greater depths.

The usar soil may also be reclaimed by the application of heavy doses of molasses (25 to 35 tons/hectare). N.R. Dhar and S.K. Mukerjee suggested that molasses containing
2% of acid and 60 to 70% of carbohydrates creates acidic conditions in the soil due to the production of organic acid which neutralizes the alkali nature of the soil. Organic acid produced in large quantity from the decomposition and oxidation of carbohydrates, which converts sodium carbonate into bicarbonates. The carbohydrates materials present in molasses helps in the growth of Nitrogen fixing bacteria like Azatobacter in the soil. The calcium which is present in the molasses helps in converting the sodium soil into a calcium soil which is a normal soil.

Satisfactory results have been obtained in Uttar Pradesh on reclamation of usar lands with the help of green manuring and gypsum. In this case, the fields, on the basis of soil properties are treated with specific quantities of powdered gypsum and water is allowed to stand in them till the completion of the reaction. Then the water is flushed out and the crop like Daincha is sown as green manure at the rate of 40 kg per acre. After 6 weeks, the crop is ploughed under and thus the field is ready for the cultivation of varieties of Paddy.

According to Prof. M. Shafi, the general procedure of reclamation of usar soil is simple. He suggested that the usar land should be divided into small plots with field embarkment. These fields should be levelled and thoroughly ploughed during early summer and filled with water. Paddy straw and undecomposed bulky organic matter should be applied uniformly in the field. A regular supply of water should also be maintained till July. This process should be repeated for 3 years but during the fourth year dha fragrance be sown in the beginning of May and ploughed down in the soil in June 1. Then in July the field should be transplanted with paddy which will give good yield. Paddy is followed by gram or peas. In clayey soil the rotation of paddy-pea should be permanently followed. Where as in lighter soil, dha fragrance is sown in Kharif and is ploughed down in the middle of August. If wheat after dha fragrance gives better yield, the land may be considered as fully reclaimed and the normal farm operation may be followed.

CHAPTER - II

AGRICULTURAL TRANSFORMATION - A CONCEPTUAL FRAME WORK

The objective of development is to raise the level of living of the people and to provide all human beings the opportunity to develop their potential.

The concept of crop productivity is one of the important aspect in the concept of agricultural development which is a multidimensional.\(^1\) Productivity of the crop is judged not only from the quantity but also from the variety and quality of the produce. The concept of agricultural development in a region means, by and large, an improvement of the productivity from land both per acre and per man-day. In many areas this means the supply of inputs to farmers to enable them to increase production. The diversification of cropping as an element of agricultural development is being supported on consideration of self reliance in agricultural production and maintenance of soil fertility. Diversification of agriculture must be constructed as the second vital aspect of agricultural development. It stands for production of dairying, cattle rearing, poultry farming, pig raising and fishing. These activities not only significantly contribute to the store of agricultural produce

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but also generates additional employment opportunities for the surplus agricultural population.

Commercialization of agriculture is third dimension of agriculture development. The degree to which market forces have penetrated on area and the scale upon which they operate will be the crucial factors in almost every question of agricultural development (Hunter 1962). The percentage of cropped area under cash crops may be used as a measure of commercialization of agriculture. The development of agriculture is to be judged also from the degree of equality in farm incomes and nature of agrarian relations. Above all agricultural development should not produce deterioration in ecological balance. It should not lead to deforestation, exhaustion of soil fertility, depletion of underground water, emergence of waterlogging conditions. Conservation of physical resources is an integral part of the agricultural development.

The study of geographical literature covering agricultural development in India suggests that seldom an attempt is made to define agricultural development and to select criteria in the light of any conceptual framework. Rarely a distinction is made between the elements of agricultural development and the factors in agricultural development. Focus on productivity dimension is dominant.

A composit index of agricultural development based on three factors - the growth rate of agricultural output, the use of modern input in agriculture and the productivity per hectare was constructed by Nath (1969) to compare the level of agricultural development in various states of India.3

Sharma in his work pointed out that agricultural development should be measured not only by level of productivity or trends in agricultural production but also with reference to various physical and cultural inputs like irrigation, fertilizers, insecticides, improved variety of seeds and extent of cultivated land. Agricultural development depends on application of inputs like fertilizers and water. Agricultural development is considered to be reflected in productivity of cultivated area as well as income per holding.

Agricultural development is a much more comprehensive concept than normally understood. Productivity is only one of its dimension. Agricultural development in a true sense, denotes the quality of agricultural system of a region in terms of productivity, diversification and commercialization. Besides the level and the rate of agricultural development may also be distinguished. The former represents a picture prevailing at a particular point of time while the latter

stands for the progress achieved over a given period. If the progress of agricultural development is regulated on systematic lines, it becomes agricultural development planning.

After the period when India got freedom, particularly during the last two decades, there has been considerable change in almost all the parameters of agriculture in India characterised by marked regional variations. There has been vertical and horizontal expansion in the field of agriculture. From time to time the government of India has introduced new programmes and policies for the development of agriculture. The importance of agriculture at present can be judged from the fact that its problem and planning for better production in regional perspective have attracted considerable attention of the Indian Geographers.

For maximizing the crop production, the best use of available land has to be made and the latest methods of crop production are to be put into practice. The net sown area has increased considerably and the gross cropped area has been doubled. In Uttar Pradesh large number of agricultural area has come under irrigation. Waste lands has been reclaimed and the areas under forests and other cultivable waste has decreased. The cropping pattern has undergone a change. Now more and more emphasis is being given to the cultivation of high yielding varieties of crops which are
more profitable and give better results, coarse grains are being replaced by fine grains which are also more profitable.

**AGRICULTURAL PLANNING**

India is predominantly an agricultural country. About 75 percent of the total population of the country is engaged in agriculture and this sector of economy contributes about 50 percent of the national income. The basic point of concern is the low agricultural productivity per acre. The reasons for the low yield are the small holdings, the fragmentation of land holding, the defective land tenure system characterised by high rents, lack of adequate credit facilities, absence of irrigation facilities and excessive pressure of population on land. The other reason are lack of incentive to adopt the modern technological innovation and wide variations in agricultural output due to vagaries of Indian monsoon.

A new strategy for agricultural development is being implemented from 1966-67. It includes the use of High yielding varieties (H.Y.V.) of seeds over large areas, development of irrigation facilities, adequate and balanced use of fertilizers, adoption of plant protection measures and a well organized and systematic supply of inputs including credits through institutional and other financing agencies. The other efforts has been made to bring science and technology closer to the farmers through education and training.
The special emphasis is being laid for the uplift of the weaker section of rural population, particularly the small and marginal farmers, agricultural labours, etc.

The development of Indian agriculture has been taken place into various phases which are discussed below with reference to five year plans. In the first five year plan, high priority was given to agriculture, including community development. An amount of Rs. 291 crores was spent on agricultural development. This plan was known as agricultural and irrigation plan. The main aim of plan was to make up the deficit in food grains and raw materials which was caused by the partition of the country into India and Pakistan in 1947. The strategy for this was made to extend irrigation facilities, to provide improved seeds, fertilizers and other inputs. It has brought organizational and institutional changes through land reforms, agricultural extension and community development programmes. This programme got a considerable success particularly in raising the production of wheat and rice.

During the second plan much attention was paid towards the industries and transport. Only 20 percent of the total outlay of Rs. 4,600 crores was spent in agriculture, irrigation and community development.
Failure on the agricultural front made the planners attentive during the third plan. Again in this plan priority was given to agriculture. The total expenditure on agriculture and irrigation in this plan was Rs. 1,743.6 crores. The main target set during this plan was to increase agricultural production by 30 percent. The planning commission held that the "development of agriculture based on utilization of man power resources of the countryside and the maximum use of local resources, hold a key to the rapid development of the country."

In pursuance of this new strategy of agricultural development, the intensive Agricultural Districts Programme was started in 1960-61. This programme popularly known as Package programme was taken up on plot basis and was initiated in some districts in 1960-61. By the implementation of this programme many farmers were benefitted. In 1964-65, in its modified form of the Intensive Agricultural Area Programme it was extended to several other parts of the country. This programme was concern with specific crops and the promotion of intensive agriculture. But this scheme failed because of the use of low level of farm technology. During third plan period the agricultural production was much below than it was in 1960-61. The index of rice production fell from 137.7 in 1960-61 to 121.6 in 1965-66. But there was improvement in the production of sugarcane, Tea and Coffee. This fall
in agricultural production was due to the bad weather conditions.

The Fourth Plan was started during 1966-69. In the meantime Green Revolution took place. This encouraged the farmers of the fourth plan to evolve a new strategy of agricultural development in the light of experience gained during three annual plans. During fourth plan period, a steady progress in case of all important agricultural inputs was made. Total area under high yielding variety seeds increased from 9.20 million hectares in 1968-69 to 25.45 million hectares in 1973-74, recording a growth of 176.6 percent. Similarly total intake of fertilizers increased from 1.76 million tonnes in 1968-69 to 2.84 million tonnes in 1973-74.

Fourth plan provided improved seeds, manures, fertilizers, pesticides, insecticide, implements and machinery through co-operative and state agencies. The agricultural development plan also included measure of plant protection, minor irrigation, soil conservation and land reclamation. The main aim of this programme was to benefit the small farmers. A small farmers development agency was setup in 45 selected districts. The main function of the small Farmers Development Agency was identify the problems of small
farmers, prepare appropriate programme, to ensure the availability of required inputs, extension service, and to provide credit and also to evaluate the progress from time to time. A sum of Rs. 115 crores had been allocated to benefit for small farmers.

The Fifth five year plan (1974 to 1979) allocated Rs. 7,411 crores for the development of agriculture and irrigation. This plan laid down the strategy for long-term planning of agriculture and exploitation of ground and surface water resources, application of new technology in agriculture and programmes for supply of inputs for weaker section of society. During this plan the growth rate in the agriculture and allied sectors was estimated at 3.94 percent, that of foodgrain at 3.62 percent and non food grain at 3.94 percent per annum.

In the year 1974-75 the production of foodgrains rose to 121.03 million tonnes from a level of 99.8 million tonnes. The output of rice rose to 25 percent from 39.6 million tonnes to 48.74 million tonnes. The output of coarse grains increased by nearly 3.8 million tonnes. Thus under new strategy of agriculture, the use of HYV seeds, chemical fertilizers, pesticides and machines are responsible for remarkable increase in agricultural production and productivity.

5. Fifth Five Year Plan, 1974-79
In the Sixth five year Plan (1979-84) 26.3 percent of the budget was allocated for the development of agriculture, allied activities, irrigation and flood control. The aim of agricultural and rural development during this plan period was growth with social justice, achievement of full employment in the rural areas within a period of ten years and removal of poverty from the country. The command free development programme was also started during this plan. The sixth plan also witnessed the starting point of an Integrated Rural Development programme based on decentralised micro level planning at block level. Each block was granted a sum of Rs.5 lakhs for intensive development in such activities as intensive agriculture, mixed farming, land development, and irrigation etc. The Integrated Rural Development Programme was particularly focused on small and marginal farmers & agricultural labours to achieve the twin objectives of generating employment opportunity and increasing production.

As part of the strategy of area approach, the state bank of India and its associate Banks have opened 384 agricultural development branches and financed 11 lakhs farmers upto 31 December 1975 with a total grant of Rs. 274.7 crores.

According to F.A.O. Indicative world plan for agriculture development was chalked out to analyse the problem
as a whole in an integrated way and in sufficient details to serve as a basis for policy guidance to the developing countries and for developed countries. This plan is being prepared with two time horizons namely a 10 year prospective upto 1975 and a 20 year prospective upto 1985. The F.A.O. proposed to place the problem of agricultural development within the framework of overall economic development after taking into account the existing national plan and policies and the production possibility by 1975 and 1985. It is proposed to indicate the order of magnitude of the physical inputs that may be required and to space out the nature of economic and institutional changes which might be necessary. This plan also gave the guidance on over all balance necessary between agricultural development on the one hand and industrial development on the other. 6

Other strategy for agricultural development recently introduced in the country is of multiple cropping, which aims at maximizing production per unit of land and per unit of time by taking three or four crops from the same piece of land in a year. This has been made possible because of the new short-duration high yielding varieties and improved agricultural technology available in India. The tractors, pumping sets, chemical fertilizers, HYV seeds and pesticides etc. bring about a great revolution in the development of agriculture in India.

CHAPTER - III

TECHNOLOGICAL AND INSTITUTIONAL FACTORS IN AGRICULTURAL TRANSFORMATION

TECHNOLOGICAL FACTORS:

India is trying her best to introduce new implements and various scientific techniques to raise the level of agricultural production. The land and man are the two ingredients on which agricultural production fully depends.

The efficiency of technological and institutional factors is affecting only when the land and man are in proper condition. Technological change is one of the important forces which alter the structure of agricultural production process. The term technological change is used here in a broad sense to include all kinds of inventions and innovations aimed at increasing the efficiency of agricultural production.¹ Technological change is the key to rapid rate of growth in Indian agriculture, that is in continuous economic adjustment of farm organizations to absorb technological improvements on a profitable basis. The proper combination of various improved technological factors, such as, ensured agricultural innovations, use of chemical fertilizers, high yielding varieties of seeds, modern agricultural machinery and

implements, pesticides, irrigation and several other improved farming techniques, originate a new direction of fertilization of agricultural commodities and gives much higher returns.

The rate of application of modern technology in agricultural production has been considerably increased. The physical and value productivity of farm resources has changed continuously under the constant flow of innovations in agriculture over the past half century. Now the government has become aware of the need for a package of improved practices, including high yielding variety of seeds, chemical fertilizers, better irrigation facilities, crop protection by pesticides, improved modern implements and generally higher standard of farming and in these conditions production has increased very rapidly. Farmers in many areas show a new awareness in obtaining higher yield per acre by the use of purchased inputs.

The present mode of the availability of fertilizers and its use in many areas is perhaps the most striking indication of the transformation that are taking place. Much attention has been focused on the fast increase in productivity promised by high yielding varieties of cereals. In the development of Indian agriculture, speedy and extensive introduction of technological change is one of the most important factors. This factor throughout the
history of mankind in general and during the recent past in particular have played significant role not only in overcoming various environmental constraints on agriculture but also in bringing further changes and development in existing ones. A number of methods has been developed to increase productivity by using fertilizers and better techniques of working the soil. Control of life process of plant and animals has been achieved through improved breedings, development of hybrid seeds, researches into such basic process as photosynthesis and finally control of pests and weeds through the development and manufacture of pesticides, fungicides and herbicides.

Increase in the cultivated area are often due to the technological improvement, as when better varieties or less costly cultural methods make it economically feasible to produce crops in sub-margin areas. In any event, acreage as well as yield per acre must be taken into consideration in assessing the effects of technological improvements in any country. The technological implements have brought and great change in the agricultural development of the lower Ganga-Yamuna doab region since 1960. It will be useful and interesting if we can identify and measure the various technical advances that are mostly responsible for the

transformation of agriculture. In recent years, significant changes have taken place in agricultural technology of India. The new agricultural technology consists of biochemical and chemical innovations. Biochemical innovations are one of the gifts of science and refer mainly to inputs which have a physiological effect in increasing productivity from a given land base. High yielding seeds, chemical fertilizers, pesticides etc. are examples of such innovations. Mechanical innovations are the gift of engineering and refer mainly to inputs which have a physiological effect in increasing timeliness of field operations. Biochemical innovations are generally labour absorbing, land saving and neutral to scale of operation while mechanical innovations are generally labour displacing and biased to scale. Biochemical innovations call for a high dose of working capital while mechanical innovations need huge capital investment. But these innovations have increased the production of agriculture.

In our country the average use of fertilizer is very low. It varies from 125 to 165 kilograms per hectare as against the recommended dose of 325 kilograms per hectares. However, an attempt has been made to analyse the factors which influence the use of fertilizers in the fields. The economic condition of the farmers is one of the major factors in this respect. Illiteracy is one of the crucial factors

influencing the technological change in Indian agriculture. In brief the technological change in agriculture consists of adoption of farming techniques developed through researches and calculated to bring out diversification and increase in production and greater economic return to the farmers. High agricultural production greatly depends on the use of fertilizers, improved seeds, irrigation facilities and new agricultural implements. The fast and extensive transformation of agriculture depends on technological change and spatial diffusion of agricultural innovations.

(By the Hindustan Time Jan 29, 1986) A balanced application of phosphatic and nitrogenous fertilizers, instead of only the low cost nitrogen as practised presently, is the main strategy for increasing productivity of wheat, rice, pulses and oilseeds in country's rainfed areas. Mr. J.S. Kanwar, a Scientist of the International crop Research Institute for semi-arid Tropics (ICRISAT) Hyderabad said. 

In a paper read at the regional seminar organised by the International Phosphate Institute (IMPHOS) on the theme "rainfed agriculture in southern Asia" here, Mr. Kanwar said the present deficiency of phosphorous in the semi-arid tropics

including India, is limiting crop production "more serious than is generally realised."

In another paper, Mr. J. Venkaleswarlu of the central Research Institute for Dry land Agriculture, Hyderabad, said rainfed areas, which constituted 70 percent of the total cultivated area, were more in need of fertilizers.

Phosphorous has two main functions: Transporting energy and bearing the message of heredity, thus showing that phosphorous can be one of the major factors limiting growth and development of plant and all animal species including man.

The deficiency of phosphorous can be corrected only using water soluble phosphates. Partially, acidulated rock phosphate can also be used effectively for removing phosphorous deficiency.

He has suggested that farmers should cultivate more legumes like pigeonpea, (Arhar) chickpea, Soyabean, moongbean and ground nut in these areas by using short duration and higher yielding varieties coupled with appropriate doses of nitrogenous and phosphatic fertilizers.
Modern Agricultural Implements:

Modern agricultural implements are the most important weapons for the agricultural transformation in India. Farm machinery and implements are of the recent origin in the country. It is only after independence that serious efforts were made to introduce modern agricultural machinery and implements in the country for the agricultural operations. In the initial stage the use of such implements were confined to the rich landlords and peasants who could afford the expenditure. The medium and small farmers still adopted the traditional method of cultivation. During the last ten-fifteen years an impetus to use modern machinery was given and clever and intelligent farmers were quick to realise the advantage and adopted such implements. To purchase such agricultural implements, some commercial banks and government institutions came to provide aid to the small and medium farmers in the form of loans at very reasonable rate of interest. These schemes has helped a lot to the small and medium farmers in India. With the help of these agricultural implements and machinery the farmers have improved their agricultural production per year. Mechanization or wide use of farm-machinery, tools

and implements; rationalisation or application of science to different components of production i.e., improving the soil and making it most suitable for cultivation, soil conservation, seed selection, developing plant protection, use of atomic energy and several other scientific methods of raising yield per hectare; chemicalization or sufficient use of chemical fertilizers; irrigation or utilization of water resources; rural electrification, means of communication and transport, institutionalisation or the development and effective functioning of the institutions of planning, financing, execution, education, training and research are the basic components of agricultural transformation. The agricultural transformation thus brought about is bound to increase per acre productivity, rise per capita productivity, reduce cost of production, increase the income of the farmers, create possibilities of capital investment in agriculture as also in other sector of economy and results in commercialization of agriculture less exposed to the hazards and vagaries of weather and climates etc.

The present supply of agricultural machinery, tools and implements such as in India is quite insufficient to meet the existing requirement. At the initial stage the import of farm machinery could be favoured but ultimately the manufacture of big and small farm machinery inevitable.
The agricultural machinery, tool and implement plants should necessarily be under the control of public sector. This would enable reliability in design, quality and safety and ease of operation and adjustment. Beside the availability of machine, technical know-how is equally important.

The ever increasing requirement of insecticides, weedicides, herbicides and pesticides will have to be met by the establishment of some new plants capable of producing different types of insecticides, weedicides, herbicides and pesticides in different parts of the country wherever it is feasible. These newly established plants should necessarily be under control of public sector.

A plant protection organisation will have to be established as a chief agency for plant protection programme. The precise type of organisation will be dictated by its functions, which have been defined as at least to be able:

i) to advise growers in disease and pest problems and assist them in the self and efficient application of control measures;

ii) to organise and carry out control operations which are beyond the ability of individual farmers;

iii) to carry out demonstrations and trials to meet local requirements;
iv) to carry out surveys for the determination of the
distribution and prevalence of crop diseases and pests;
v) to disseminate information; and
vi) to enforce national legislation concerning plant
protection.

Nearly every state in the country has substantial
amount of waste plant material from crops and organic garbage,
but little use seems usually to be made of this material. It
is possible to compost such waste and return it to the soil
as valuable organic matter. But even then supply of inorganic
matter in the form of chemical fertilizers and potash forms
an essential pre-requisite in the programme of new agricultural
transformation.

The better use of water in agriculture is one of the
major step towards raising productivity. Thus irrigation is
a must for the programme of new revolution in agriculture. It
will ensure the output of foodstuffs and other crops, irrespective
of the whims of nature. Irrigation may be possible through
major, medium and minor irrigation projects. Mechanization
enables the farmers to built terraces, ditches, watering ponds
and canal which help to protect soil fertility and make full
use of water supply. In addition mechanical water pumps
facilitate large-scale irrigation and drainage operations.
Rural electrification also forms an essential part of the programme of agricultural transformation. Uses of electricity are numerous e.g. in lifting water for irrigation, in workshops, in driving machines, in rural industrialization, etc. Electrification of the farms under transformation in agriculture is an essential pre-condition for a success of the programme. Development of modern means of transport and communication in rural areas too, should be provided. Roads construction work should be started on a mass scale. Surplus and displaced labours may very well be absorbed in the programme of road construction as also in rural irrigation work.

The cultivators should be provided opportunity for obtaining inputs used in different agricultural operations without any difficulty. As they obtain salt, oil, soap, cloth and other commodities of daily use from the market without any difficulty, so also they should obtain good quality inputs without any harassment from the open market. If this principle is adhered there seems to be no reason of production being hampered on account of lack of inputs. The ease of distribution could only be possible if the availability and supply of inputs is raised manyfold to meet the ever increasing requirement of the land and its people.
Use of fertilizers

It is one of the most important inputs in the farm operations. At present India is facing difficulties in developing an adequate supply of cheap fertilizers among her farmers. According to the statistics published by fertilizer Association of India, in 1970, there were as many as 48 factories already in production in 1970, 8 were under construction, 11 were approved in principle and 4 were in proposal stage. The demand of fertilizer has gradually increased during the process of transformation of agriculture after sixties and the introduction of H.Y.V. programme has further augmented the use of fertilizer. Consequently more fertilizer factories have been established all over the country. There are three agencies through which fertilizers are distributed in the country and these are: (a) The government fertilizer depots (b) The cooperative and (c) private dealers.

The modern use of fertilizers began with the manufacture of superphosphate by John Bunnet Lawer in 1843. Its use at the beginning increased slowly but at present it has been rapidly increased to enhance crops production. The world consumption of fertilizers has increased three times during the last two decades. Adequate use of fertilizers with sufficient irrigation can increase production five times than without fertilizers. In 1970 in India only 10.74 kg.
of nutrients were supplied on an average to a hectare of land as against 626 kg in Netherlands, 371 kg in Japan, 76 kg in U.S.A. while the world's average is 37 kg. But the rapid annual increase has been recorded in the recent years. The annual average consumption of fertilizers per hectare during 1975-76 to 1977-78 was 18.7 kg. in India as compared 404 kg. in West Germany and 396.4 kg in Japan. The world's average here is 61.8 kg per hectare. From the above facts we can say that within the limited period of 8 years the fertilizer consumption in India has become almost double. This consumption however varies from state to state. It is comparatively low in Assam, Bihar, Orissa, and Rajasthan.

Urea and sulphate of ammonia are the most promising chemical fertilizers available to the cultivators for improving crop yields and is getting increasingly useful application in Indian agriculture on a variety of crops. The response obtained by its application is both quick and certain. After application of this fertilizer the yield has gone up to 25-100 percent has been reported.

Experiment conducted in Ranchi Agricultural College shows that the use of phosphorite in chemical fertilizer doubles the yield of wheat and soyabean. The other

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6. Nair, K.N.S., Technological changes in Agriculture, consumption of Fertilizer, New Delhi, 1980, P. 141.

experiment by the Central Salt and Marine chemicals Research Institute, Bhavnagar in Gujrat has developed a process for manufacturing potassium fertilizers which is suitable for crops. The exhaustion of soil fertility is removed by the application of proper chemical fertilizers. Soil is a great natural store house of all nutrients needed for successful plant growth particularly of organic chemicals like nitrogen, Potash and phosphoric acid (N.K. and P).

The table... give an idea of the enormous quantity of these elements which are removed from the soil by different crops.

<table>
<thead>
<tr>
<th>Types of Crop</th>
<th>N</th>
<th>K</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>54</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>Wheat</td>
<td>35</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Potato</td>
<td>76</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Cotton</td>
<td>75</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>Jowar</td>
<td>26</td>
<td>7</td>
<td>16</td>
</tr>
</tbody>
</table>

Fertilizer is the key input in increasing agricultural productivity. Every tonne of fertilizer increases the yield
The consumption of fertilizer is thus a good indicator of the country's performance in crop production. In the year 1979-80 the fertilizer consumption in India was 52.56 lakh tonnes. In 1980-81 it is about 54 lakh tonnes. To ensure that the right type of fertilizer reaches the farmers in the right quantity, at the right time and at right price, a number of innovative measures have been taken in this direction.

**High yielding varieties of seeds:**

Every farmer is aware of the potentiality of H.Y.V. seeds in raising the agricultural production. The new strategy, therefore, in essence called for implementation of the H.Y.V. programme. Considering the progress made during last four-five years, the new strategy promises a higher rate of growth in food grains production and attainment of self-sufficiency. The H.Y.V. programme is the main plan of the new agricultural strategy. This programme covers major food crops such as wheat, rice, maize, Jowar, and Bajra. The success of this programme could be judged as to what extent agriculture has been transformed and to what level the production has been augmented. Since 1965-66 which is known as the base year of the new agricultural strategy, the wheat production has increased three fold and rice production by more than 76 percent. Jowar, Bajra and maize

has made a little progress because of the lack of suitable hybrids and incidence of pests and diseases on some of the hybrids. The coverage of area under this programme has registered a sharp increase, from 18.9 lakh hectares in 1966-67 to 4.20 crore hectares in 1978-79 and 4.80 crore hectares in 1980-81.

Beside wheat, rice has also made a sharp progress in the production. An important development in rice cultivation is the replacement of coarse high yielding varieties of rice by high quality finegrain varieties like Ratna, Vijaya, I.R. 20, Saket, Mahsuri and a number of IET selections. As a result of the introduction of H.Y.V., rice production is also increasing at a faster rate in the non-traditional rice growing states, like Punjab, Haryana and Western Uttar Pradesh.

The country has attained self-sufficiency in seeds of high yielding varieties and is in a position even to export these seeds to other countries.

Irrigation:

India is monsoonal country. Here rainfall received by monsoon is not sufficient for agricultural purposes and lack of soil moisture frequently reduce crop yield. In such a condition, irrigation is used to supplement rainfall as and when necessary to provide sufficient amount of moisture.

for the crops. Irrigation is the most important input in the process of agricultural transformation.

Most of the Indian agriculture is carried out under rainfed conditions. In many areas production is not possible without proper irrigation and in other areas supplemented irrigation makes it possible to maintain production at reasonable levels and to avoid crop failure due to unstable rainfall. The most effective policy of irrigation will vary from one area to other. It has recently been suggested that the country can be divided into three broad groups of areas according to the character of water supply and the stability of production and for that different policies are required for each of these areas. The first area where there is an assured water supply both in volume and in spread either from assured rainfall or from source of irrigation. In these areas irrigation policy should be intensive and the aim should be to maximize the per hectare yield of different crops by multiple cropping method.

Uttar Pradesh is one of the most important agricultural state in India. Here the main source of irrigation is canal irrigation and Tube-well irrigation. Besides there are tank irrigation and well irrigation also. For getting the maximum benefit from irrigation, a region requires at first an increase

in the number of canals, tube-well, tank etc. Secondly, the loss of irrigation water through evaporation and seepage must be reduced through various techniques. Thirdly, such type of technique should be adopted which should be cheap and lifts water to a higher level, if required. Lifting of water to a higher level is done either by manpower, bullocks, or mechanical power such as oil engine with pump or electric motors with pump. Fourthly, in India the methods of irrigation being used is not much efficient. The selection of most suitable irrigation for each field, carefully applied, will contribute greatly towards increasing crop yield.

It is a well established fact that irrigation is the life breath of agriculture. Its importance in the transformation of agriculture in general and in monsoonal countries in particular hardly needs any emphasis. Very often it plays a decisive role in the selection of crops to be sown, cropping pattern, intensity of cropping, crop combination, extent of yield and the time of sowing the crop etc. A number of analytical studies have proved that India can increase its agricultural production to a very large extent, if adequate and assured irrigation facilities are available.  

Use of Pesticides and Control of Diseases:

Several institutes including the Central Food Technological Research Institute, Mysore, and the Indian Agricultural Research Institute, New Delhi, have done analysis of various pesticides. In total about 1,000 pesticides are used throughout the world. About 250 pesticides are used in agriculture, of which hundred are insecticides, 50 herbicides, 50 fungicides, 20 nemacides and 30 other chemicals. D.D.T. as a pesticide has been used to kill insects that destroy crops. This type of pesticide has improved the economic, social and health status of developing countries.12

Use of pesticides in India started only after independence and the first plant to produce pesticide (BHC) on commercial basis was setup in the year 1952. The first public sector D.D.T. plant came into existence in 1955. The use of pesticides in India increased from 3,750 tonnes per year in 1952 to 25,000 in 1957 and 45,000 tonnes in 1962. The total requirement of pesticides for the year 1978-79 was 77,420 tonnes.

Weeds grow besides the crop and compete for moisture, light and nutrients, and thus reduce the yield of the main crops. Weed grows on land as well as in water and on all

type of soil, at all elevation and in all seasons. It has been estimated that the average yearly losses due to weed in crop lands is greater than due to animal and plant diseases.

There are certain weeds which are poisonous to man and animals. Weeds usually grows faster than crop plant and thus prevent the crop plants to get proper sunlight. The only way to avoid losses in crop production by weeds is to control the weed by practicing clean cultivation. If the proper weed controls in all farms of India are practiced there will be 10 to 25 percent increase in agricultural production.

Insects and pests are the most dangerous elements which destroy and reduce the production of crops. For plant protection measures, the insects, diseases and pests can be checked to increase the yield of the crop. The organism, causing disease of plant may be either plants or animals. The animal pests largely belong to insects but snails, slugs, crabs and rodents are also the pests. Large animals such as wild boar, Jackal, deers, and Elephant etc. also destroy the crops.\(^\text{13}\)

The use of chemicals for controlling the diseases and pests are widespread in the world today. The chemicals used in agriculture for pests and disease control depend to a large extent upon the availability of suitable machinery for applying them, because it is used in different forms such as dusts, sprays etc. The three main groups of pest control chemicals are the insecticide, herbicides, and the fungicides. Chemicals such as D.D.T., Parathion, Diathion, Schadam, TMPP and METP. Still 2,4,S-T and TAC have been recently introduced and various techniques are used for the application of these chemicals in the fields. These control measure of weeds, resulted in a great agricultural transformation by which the agricultural productivity is raised upto a very high level.

INSTITUTIONAL FACTORS:

Institutional factors plays a very important role in the transformation of agriculture. It includes land consolidation, credit supply, cooperative society, land tenure and land revenue, land holding, and size of holding. These factors plays a very significant role in the transformation of agriculture in lower Ganga-Yamuna doab.

Land consolidation:

Agriculture is the basic occupation of the Indian population. The term land consolidation has been defined
as an amalgamation and redistribution of all or any isolated and scattered unit of individual plot into one consolidated compact field.  

As we all know division and sub-division of holding results in the inefficient and unprofitable farming. By means of consolidation of holding, all the scattered plots are consolidated in a compact farm of larger size which is equivalent to the area of all the scattered plots put together. Once all the scattered fields of a farmer became compact or consolidated, then it became easy to make use of the modern technique of cultivation. Now the farmer can erect tube well in his consolidated fields and can use newly developed techniques of agriculture, e.g., high yielding varieties of seeds, chemical fertilizers, irrigation, pesticides, insecticides, tractors, harvestors, threshers etc. Thus we can say that the consolidation of holding has a direct effect on the productively of agriculture and thus by consolidation the Indian agriculture has been transformed into a right direction.

Land Tenure:

Of the various factors that contribute to the well-being of the agricultural industry, the system of land tenure

is by far the most important. The term "land tenure" stands for the system of rights and obligation of the members of the rural community in relation to the landlord and state. It refers to the terms or conditions upon which land is held or possessed. In brief, the system of land tenure relates to the question of intermediary interests, land utilisation and distribution of farm income. Obviously the system of land tenure is ideal in the sense that it provides (i) The maximum utilisation of land in the general interest of the community, (ii) most efficient cultivation and progressive farming, (iii) fair distribution of farm income, (iv) opening up of opportunities for a further development of peasants personality, and (v) peace and social progress in the country side. The cultivator will have the incentive to produce more and better only when he enjoys security of tenure and is assured of fair return for his labour. At the same time it should be so designed as to promote the well being of the whole man and to subserve desirable social ends. Certainly social values must not be sacrificed for the sake of economic efficiency.

Before we study the land reforms, it will serve as a good background to know the main features and defects of the prevalent land system before the introduction of reforms and also the various alternatives that can be suggested in this connection.
Main land tenure of India before the Reform:

Broadly speaking, the land in most part of India before the agrarian reform was held in one of the three major systems. These were (i) the permanently settled estate system, (ii) the temporarily settled estate system, and (iii) the Ryotwari System. The permanently settled estate system covered nearly 25% of the area. It prevailed in most parts of Bengal and Bihar, about one-half of Orissa, one-third of Madras and smaller parts of Assam and Uttar Pradesh. The temporarily settled estate system accounted for 39% and prevailed in Uttar Pradesh, Madhya Pradesh, about one fourth of the state of Orissa and in some areas in the states where the permanently settled estate system prevailed. The Ryotwari system, which covered about 36% of the land, prevailed in the rest of the country.

The broad distinguishing features of these three major land systems of the country were briefly as follows: The revenue was fixed in perpetuity under the permanently settled estate system, whereas it was revisable under the other two. Another well known feature was that while under ryotwari the land revenue was assessed on individual pieces of land and the actual occupant, who possessed a permanent and heritable right of occupancy, was liable for its payment; under the permanently and temporarily settled estate system, the unit
of assessment was the "estate" and the holder of the estate (commonly called the proprietor), and not the actual occupant of land, was responsible for the payment of land revenue.

In this connection, it is necessary to refer to an essential common feature of all the three major systems. There was in respect of every individual piece of land a person known as occupancy-right holder. He held the land on a permanent and heritable tenure and generally also possessed the rights of transfer. Under the ryotwari system the occupancy-right-holder paid land revenue to the Government while under the other two systems he paid rent to the proprietor of the estate. Both the payments were similar in character in the sense that they were not determined on a purely contractual basis. Generally speaking, occupancy-right-holders, instead of cultivating lands themselves, used to lease their lands to tenants and they, in their turn, to sub-tenants on terms which inhibited efficient cultivation. Thus not land but man behind the plough used to be exploited.

**Defects of these systems:**

Under all the existing land systems small holdings were the rule, large holdings were relatively few in number.
There was to be found a strong tendency, which was directly attributable to the right of inheritance and transfer of land, to a progressive diminution in the size of holdings and their fragmentation. This increasing subdivision and fragmentation of our agricultural holdings constituted as one of the principal defects of our land system. It stood in the way of poorer utilization of land, leading to poverty of the soil and poverty of the cultivator.

Further, and that is even more serious, there was the great evil of sub-letting. This evil was not confined to any particular system; it was universally present, though in different degrees, in all the different forms of our land system. Taking the country as a whole, about 80 percent of the land was cultivated by farmers who did not own the land. In other words, four-fifth of our land was in the hands of absentee landlords who were simply rent-receivers. They did not themselves attend to cultivation but gave their lands on lease to tenants for purposes of cultivation. In many cases the tenants also did the same thing, sub-letting the lands to others. Thus there grew a large number of absentee landlords and intermediaries between the actual tiller and the state who extracted income from land without performing any useful function.
Although the terms of tenancy varied, it was generally based on the crop-sharing system. The tenant had to bear himself all the expenses of cultivation and was usually required to pay over 50 percent of the gross produce as rent. Obviously in a country of small holdings, such high proportions of the rent payment were excessive. Certainly this amounted to rack-renting. More often than not, the proportion of the produce that remained with the tenant after meeting the expenses of cultivation and payment of his rent, used to be simply insufficient to maintain him and his family. No wonder then that he remained so poor; and being poor, he lacked the means to effect improvements on his holding or even to maintain the existing low fertility of the soil. This naturally hindered production and made agriculture backward. The cultivators very frequently had to turn to the money lenders for help, a very costly help indeed, resulting in alienation of land and steady increase in the number of landless proletariats.

Thus, in brief, our land system resolved into one where land was nobody's concern. The tiller had a depressed status. He was rack-rented and poor. He also lacked security. Consequently he had neither the means, nor the necessary incentive to effect improvements. At the same time the landlord, assured of high profits from cultivation through his tenants, felt satisfied and as such took little
interest in extension of cultivation or in making improvements on land.

In August 1946, the U.P. Assembly accepted the principle of a abolition of Zamindari system. A Zamindari Abolition Committee was appointed to prepare a scheme for the abolition of the Zamindars. The abolition of intermediary rights is no doubt a thing of great achievement in the field of land reform in the country during recent years.

**Alternative Systems:**

Broadly speaking, the alternative schemes of organisation are (i) State farming, (ii) Capitalist Farming, (iii) Collective Farming, (iv) Peasant Proprietorship, and (v) Co-operative farming.

**State farming:**

Under this system land would be nationalised and managed by government officials. The cultivators would thus be reduced to the status of wage-labourers.

The only country where state farming has been attempted on a fairly large scale is U.S.S.R. There are large number of State farms. These farms are very large in areas extending upto thousand of hectares. All the agricultural experimental activities are carried out on these state farms.
It is extremely doubtful whether in our country the scheme of state farming, if put into practice on a fairly large scale, would prove commercially and otherwise successful. Of course it would not be very fair to say that state farms can't be commercially successful, because the incentive for efficient production would be weak both in the managers and in the agricultural workers. Such an argument is raised against every kind nationalisation. But from that point of view in the modern industry also, the managers and workers are hired. They do not own the factories in which they work. Similarly in big capitalist farms, a number of paid managers and workers are engaged to run its various departments. In our country the record of the state farming is not very encouraging. In many cases state farms have been models of reckless expenditure; and if the pay of officials and other miscellaneous expenses be included, the cost of production would probably be too high.

Apart from this, state farming has many social and political implications which make it unacceptable to us on any large scale. The constitution of free India guarantees to protect the institution of private property, whereas the system of state farming involves its complete abolition. Again, it will lead to over centralisation of powers—social, economic and political, and hence will be incompatible with the democratic way of life to which we are now pledged.
Although large scale reorganisation of our agriculture on the basis of state farming will be unacceptable to us, the establishment of a number of state farms for purposes of experiments, growing good seeds, demonstrations, of improved methods to cultivators and such other purposes will be a desirable policy. The areas which are being reclaimed offer a good opportunity for the establishment of state farms. The state with its vast resources can bring such areas under cultivation and thereby increase the volume of production.

2. Capitalist Farming:

After acquiring the property rights in land, the state may auction the land to Private capitalists for scientific cultivation subject to certain conditions relating to minimum wages, condition of work, etc. It is held that such a system will lead to the fullest utilisation of land resources, and if proper conditions are imposed, it will give good wages to labours and make for better housing and other amenities. It will also facilitate the growth of agro-industries in the country.

It is very doubtful that a large number of capitalists will be ready to invest their capital in agriculture when industrial and commercial opportunities are available. This
is very well bornout by past experience. Leaving a few exceptions, hardly any interest has so far been shown by such land lords in reclamation of waste or development of their holemands. And even if we accept for a moment that private capital will be forthcoming in adequate amounts and that under proper safeguards the system will lead to improved land utilisation, it can't gain our support for it will not be desirable from social and political point of view. Surely, a system that would deprive the agriculturists of all their rights in hand, reduce them to the position of industrial labourers and subject them to capitalist exploitation hardly deserves serious consideration.

3. Collective Farming:

The essential features of collective system, its organisation and also the reasons for its unsuitability as far as our country is concerned are discussed below in brief.

Under collective farming, ownership of all land, stock and capital vests in the community as a whole. There is no private property in land and individual holdings are completely abolished. The work of cultivation is carried on the whole farm as one unit of organisation under a management committee elected from among the members. The
committee lays down programmes of daily work, direct
and supervises the performance of all agricultural operations.
It organises credit, marketing, insurance etc. and also
makes arrangements for special social services such as
education, medical aid and recreation centres.

Members of the collective farms are treated as
equal, but their wages are not necessarily equal. Wages are
received according to the nature and extent of work done
by them. The profits of the farm are generally distributed
on the basis of wages earned by each member. In certain
cases, however, both production and consumption are communal.
In such cases a member shares in everything provided
by the farm food, clothing, housing, etc. by virtue of being
a member, and not in proportion to the work done by him.
He works not with the motive of personal gain but from a
sense of duty, for the well-being of the group as a whole.

Collective farming has been tried in different parts
of the world notably in U.S.S.R., Mexico, and Palestine.
In these countries this farming has achieved a fair
measure of success.

As far as India is concerned, it has little
possibilities at any rate for some time to come. There
are both constitutional and sentimental difficulties in
its way. It involves complete abolition of the right
Of private ownership of land, a right which is highly valued in respected of this country. Even in the constitution of India, it has been recognised as one of the fundamental rights of the citizen of the country. In view of this it can be introduced only when it becomes a declared objective of state policy. But any such attempt to establish collectivisation is bound to be opposed by the peasants as a class on account of the deep attachment to the ownership of land that is to be found in the country. And this becomes all the more justifiable in case the owners of factors of production in other sectors are left undisturbed. So the question of reorganising our agriculture on the basis of collective farming would arise only when all the sectors of the Indian economy were transformed into a completely socialist system.

4. Co-operative Farming:

The system of co-operative farming offers a concrete solution for the fundamental problem of our agriculture. It provides for a re-organisation of our agricultural economy in the form of an efficient system of production. It offers an effective remedy for uneconomic holding and enables the small farmers to reap the benefits of large scale farming, to effect economic in the cost of cultivation and realise the technical possibilities of increased production.
Besides promoting economic efficiency, this form of organisation has added significance in the fact that its growth is closely related to the training of the individuals in the art of self-government. It develops social morality and also facilitates the changes over from a capitalist to a socialist economy without the use of force or compulsion. It is indeed a peaceful revolution in action.

There are many technical, financial and administrative difficulties in the way of the adoption and working of this system. Indeed the difficulties are bound to be very great during the initial stages. Yet the whole system is so well suited to the genius and traditions of the country that every effort need to be made, even if that be at the cost of some sacrifice to create conditions conducive to its establishment.

5. **Peasant Proprietorship**

A very large number of cultivators are in the view of this system of agriculture, under this system all intermediatory rights in land is abolished. The peasant is the owner of the land. He possess a permanent, inheritable and transferable right in land. He cultivate the land himself and pay the revenue fixed on his holding to the
state. There is direct relationship between the peasant and the state. At present this pattern of agricultural system is prevailing in almost all the states of the country.

The argument that are generally put forth in favour of peasant proprietorship can be summarised:

1. It will give maximum employment to the labour available.
2. It will bring about economic decentralisation and provide an independent means of support to the majority of our producers.
3. It will preserve liberty and democratic rural society and also establish social stability and self respect.
4. It will give the greatest possible yield per acre and maintain maximum soil fertility.
5. It will suit our social structure and satisfy the peasant's love for land.

The case of peasant proprietorship thus appears to be rather very strong. It has a great psychological and sentimental appeal in as much as it satisfies the peasants love for land. It provide the necessary incentive for maximum effort and efficiency. Yet it needs to be pointed out that in its pure
and full fledged form it will not be very helpful in the effective solution of our major agricultural problems. The most intractable feature of our agrarian economy is the small size of holdings occupied by the vast majority of our cultivators. As long as this feature continues there can be no effective solution of the problem of low production and crushing poverty of the cultivators. Reclamation of waste land and its distribution among landless persons will not help in increasing the size of holdings to any significant extent. Redistribution of large farms among small holdings will also not serve the purpose. The existing pattern of our agricultural economy is exceedingly complex and the problems facing it are many fold and varied. It will, therefore, be better to take into account the whole set of conditions obtainable in the country and adopt flexible land system or systems so that they may be evolved progressively out of the experience gained through our experiments. In our view cooperatively regulated and organised peasant proprietorship will be a better alternative.

Credit supply:

Credit is as essential for agriculture as for trade and industries. The farmers require it for buying livestock, seeds, agricultural implements, and fertilizers etc. So we can say that credit supply is the life blood of our Indian agriculture.
By efficient credit system we mean an institution providing adequate and cheap credit for productive purposes. In agriculture one of the main obstacles is the smallness of the income of the farmer. Generally there are live agencies which provide agricultural credit in the country, and they are -

1. Indigenous money-lenders, including even the Zamindars and tenants.
2. Cooperative societies including credit societies, land mortgage bank and marketing societies.
3. Banks
4. State managed or controlled credit agencies including the Reserve Bank of India.
5. The state.

For the agricultural development in general and adoption of agricultural innovations in particular, substantial amount of capital is required. But the Indian farmer is so poor that he can not afford it properly. He takes money at a very high rate of compound interest from various sources like middle man, money lender and commission agents for his daily life and occasional ceremonies. They exploit him to the maximum extent. The result is that the farmer hardly get rid of the debt of these agencies. It is rightly remarked
that Indian farmers, by and large are born in debt, grow up in debt, and die in a debt. For the development of agriculture, the government and various institutions are trying to help them by providing credit facilities at lower rate of interest. If these facilities are available to the farmers, they could grow double or even triple crops in a field within a year.

Several studies have highlighted the fact that if adequate and timely credit at lower interest rate is available to the farmers, they would develop their agriculture more quickly. As a matter of fact availability of adequate and timely credit facilities promote fast development of agriculture.

Cooperative Society:

Cooperative societies play a very significant role in the development of agriculture. The cooperative societies in India have so far been able to provide long term, short term and medium term loans to such cultivators who are only the members of the cooperative. Cooperative societies are regarded by far the best agency to provide productive loans to the farmers. The chief merit of cooperative finance is that it is supposed to promote the effective use of loans through efficient supervision. They get urgent and immediate financial help through cooperatives.
Next important thing is the problem of agricultural marketing because the methods of sale are primitive and very defective. Now the cooperatives are the best remedies with respect to the agricultural marketing. Cooperative marketing activities may no longer be to the disadvantage of the cultivators.

In the field of agriculture cooperative comprises almost every activity that is associated with the agricultural organization. It is the best medium for a progressive and developed agriculture. Major items of agricultural development provided by cooperatives are supply and distribution of chemical fertilizers, distribution of high yielding varieties of seeds, distribution of new implements and machinery, irrigation facilities, pesticides and spraying equipments etc.

In recent years, the role of a cooperative in fertilizer distribution has been substantially enlarged. It is functioning as exclusive agents of state Government for distribution of nitrogenous fertilizers in several states of India. The sale of chemical fertilizer by cooperatives increased from about Rs. 32 crores to Rs. 73 crores in 1963-64 in India. Cooperative finance continued to be in favour of crop loans which accounted for Rs. 83 crores in 1977. In this way, cooperatives have been contributing in several
ways to the development of agriculture especially in the supply of agricultural inputs. Cooperatives also help to the farmers in marketing and other services.

**Landholdings**

It is a very important factor for agricultural development. This has been listed as a major problem of Indian agriculture because a large number of holdings are declared as uneconomic. During the British rule in India, the condition of farmers and scope of agriculture development was very unsatisfactory. This was because the evils of the institutional factors had reached to their maximum. In the pre-independence period the story of agriculture was a story of feudalism which consisted of all evils of feudalism and land ownership. In this system of agriculture, a very large proportion of agricultural produce goes into the pocket of landlords and the farmers get a very small share from it. Above all the farmers do not have their tenure security. Therefore their interest towards the farming ultimately declined.

In the lower Ganga-Yamuna doab the land was owned by the proprietors and the farmers generally cultivate it. These owners of land were called as zamindars. These zamindars acted mainly as intermediaries between the state and the farmers. In many cases there was a long chain of intermediaries and all burden of it fell on the tiller of the land who was
a tenant. Land which was cultivated by the Zamindars themselves was called Seer and Khudkast.

Size of holding is another institutional factor and it is most important indicator to measure socio-economic status. In the study area the size of land holding is generally small. A large number of farmers has the average size of holding, from 2 to 5 acres. According to one group of scholars there is a positive and high correlation between the size of holding and adoption of agricultural innovations (Mohammad, 1978, Desai 1966, and Freeman 1961). The argument given by these scholars is that, many innovations such as tractors, Harvestors, Thrashers, Sprayers, power custer and other agricultural machinery can be used economically only in contiguous and large strip of land. It is therefore, assumed that larger the size of holding, higher is the use of agricultural innovation, and higher is the agricultural productivity. Further if the size of holding is large mechanical power can be easily be used on this holding at cheaper rate in a greater productivity.

In the following pages the author has tried to examine the relationship of modern technological input with agriculture and also tries to see that how and up to what extent these technological inputs has transformed the agriculture within the study region of Lower Ganga-Yamuna doab. Table 1 and 2, show different technological inputs of agriculture and production of rice and wheat with yield on the basis of the data collected tehsilwise for the years 1972-73 and 1982-83.
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TABLE - 3

Index of transformation of technological inputs in the Lower Ganga-Yamuna doab

(Changes from 1972-73 to 1982-83 has been calculated in terms of percentage)

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<th>Iron plough</th>
<th>Gale Harrow</th>
<th>Plant protection sprayer &amp; Duster</th>
<th>Tubewell</th>
<th>Seed drill</th>
<th>Tractor</th>
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93
On the basis of above figures of agricultural inputs (Table 1 and 2) in terms of technology and major food crops production for the year 1972-73 and 1982-83 respectively, the index of transformation of technological inputs in the study region has been calculated in Table 3.

This table shows the percentage change of technological input from 1972-73 to 1982-83. The tehsilwise ranking index of technological inputs in the study region shows that the tehsils having lowest ranking index number have higher technological inputs and vice-versa. Thus we see that tehsil Ghatampur and Khaga in Kanpur and Fatehpur districts have lowest ranking index number i.e., 28.5 and 29.5 respectively and therefore these tehsils have the highest technological inputs. On the other hand the ranking index number of tehsils Derapur, Bhognipur and Kanpur all lying in Kanpur district are highest, i.e., 50, 57, and 60 respectively, therefore these tehsils have the lowest technological inputs. The ranking index number of rest of the tehsils of the region ranges in between.

Table No. 4 shows the effect of technological inputs in the transformation of agriculture from 1972-73 to 1982-83 in terms of percentage.
<table>
<thead>
<tr>
<th>Tehsil</th>
<th>Ranking coefficient of technology</th>
<th>Change in South area %</th>
<th>RICE</th>
<th></th>
<th>WHEAT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Change in area in percentage</td>
<td>Change in production in percentage</td>
<td>Change in yield per hact.in</td>
<td>Change in area in %age</td>
</tr>
<tr>
<td>Ghatampur</td>
<td>28.5</td>
<td>0.98</td>
<td>-24.38</td>
<td>-22.41</td>
<td>1.79</td>
<td>23.28</td>
</tr>
<tr>
<td>Khaga</td>
<td>29.5</td>
<td>3.56</td>
<td>12.20</td>
<td>13.81</td>
<td>1.46</td>
<td>72.77</td>
</tr>
<tr>
<td>Bindi ki</td>
<td>38.0</td>
<td>0.03</td>
<td>-0.10</td>
<td>10.46</td>
<td>10.62</td>
<td>34.92</td>
</tr>
<tr>
<td>Bhelaur</td>
<td>40.0</td>
<td>-5.48</td>
<td>15.38</td>
<td>29.47</td>
<td>21.34</td>
<td>19.83</td>
</tr>
<tr>
<td>Akarpur</td>
<td>42.0</td>
<td>-3.87</td>
<td>12.51</td>
<td>42.58</td>
<td>26.67</td>
<td>34.85</td>
</tr>
<tr>
<td>Chail</td>
<td>46.0</td>
<td>-0.58</td>
<td>-4.14</td>
<td>7.10</td>
<td>11.69</td>
<td>51.40</td>
</tr>
<tr>
<td>Fatehpur</td>
<td>49.0</td>
<td>3.15</td>
<td>4.02</td>
<td>8.51</td>
<td>4.36</td>
<td>34.47</td>
</tr>
<tr>
<td>Derapur</td>
<td>50.0</td>
<td>-2.67</td>
<td>6.87</td>
<td>60.38</td>
<td>50.22</td>
<td>25.71</td>
</tr>
<tr>
<td>Bhognipur</td>
<td>57.0</td>
<td>0.94</td>
<td>-15.46</td>
<td>6.51</td>
<td>25.97</td>
<td>26.77</td>
</tr>
<tr>
<td>Kanpur</td>
<td>60.0</td>
<td>-3.87</td>
<td>-0.92</td>
<td>-12.84</td>
<td>-12.05</td>
<td>22.56</td>
</tr>
</tbody>
</table>
In the above table tehsils are arranged in accordance with the ranking index number and the percentage change of net sown area, percentage change of area under rice and wheat, their production and yield has been calculated. Tehsil Ghatampur has the highest agricultural inputs which results in the increase of net sown area by 0.98 per cent whereas the area under rice decreased by 24.38 percent and its yield per hectare has increased by 1.79 percent. Production of rice has decreased by 22.41 percent. This decrease in the area and production is mainly due to the less fertility of soil. In the rice sowing season (Kharif season) the farmers leave the fields as fallow land in order to regain fertility for Rabi crops. As a result the area under wheat in this tehsil has increased by 23.28 percent and production by 51.07 percent and also yield per hectare has been raised to 22.54 percent.

Tehsil Khaga has the second lowest value of ranking index number. Here the net sown area has been increased by 3.56 percent. Area under rice has increased by 12.20 percent, its production by 13.83 percent and yield per hectare by 1.48 percent. In case of wheat the area under the crop has increased by 72.77 percent, production and yield per hectare has gone to 105.48 percent and 17.19 percent respectively. This bumper increase in the area and production of
the crop is the result of higher technological inputs.

Thirdly the tehsil Bindiki where net sown area has increased by 0.03 percent. Area under paddy cultivation has decreased by 0.10 percent where as its production has been raised to 10.46 percent and yield per hectare has also been raised by 10.62 percent. In case of wheat, the area under this crop has increased by 34.32 percent, production has 43.40 percent and yield per hectare 6.32 percent.

The fourth ranked tehsil Dilhaur shows a decrease in net sown area by 5.46 percent. Area under paddy has increased by 15.36 percent the production has increased by 27.47 percent and yield per hectare has increased by 21.34 percent. It is to notice that despite of decrease in area under the crop, increase in production is a clear indication of efficient irrigation facilities. In case of wheat, area under crop has increased by 19.63 percent, its production has increased by 27.43 percent and yield per hectare has also been raised to 6.34 percent.

Next in accordance with the value of ranking index of Kangur district comes tehsil Akbarpur where net sown area has gone down to 3.87 percent. While area under rice has increased by 12.51 percent, production has been raised to 42.50 percent and yield per hectare to 26.67 percent. In case of wheat, area under crop has increased by 34.95 percent, production by 53.91 percent and yield per hectare by 14.15 percent.
Tehsil Chail stands next to Akbarpur tehsil. Here net sown area has decreased by 0.58 percent. Area under paddy cultivation has decreased by 4.14 percent whereas its production has gone up to by 7.10 percent and yield per hectare has to 11.69 percent. This decrease in the area under crop is the result of fallow land in Kharif season in the case of wheat area under this crop has increased by 51.40 percent its production 67.86 percent and yield per hectare 22.04 percent.

After Chail is the Sadar tehsil of Fatehpur district where net sown area has increased by 3.15 percent. In this tehsil area under rice has increased by 4.02 percent, its production has increased by 8.51 percent and yield per hectare of the crop has been raised by 4.36 percent. In case of wheat, the area under crop has increased by 34.47 percent, its production 69.76 percent and yield per hectare 22.04 percent.

In Derapur tehsil (of Kanpur district) the net sown area has decreased by 2.67 percent. Area under paddy cultivation has increased by 6.07 percent 60.38 percent and yield per hectare 50.22 percent. In Rabi season the area under wheat is increased by 25.71 percent, its production has increased by 34.30 percent and yield per hectare has been raised by 6.84 percent.

Tehsil Nagarpur (Kanpur district) has the second highest value of ranking index which means that comparatively
very low technological inputs are used here. In this tehsil
net sown area has increased by 0.94 percent. In Kharif season
area under rice has decreased by 15.46 percent. Its production
has increased by 6.51 percent and yield per hectare has been
raised by 25.97 percent. In Rabi season area under wheat
cultivation has increased by 26.77 percent, its production
has increased by 44.82 percent and yield of the crop has
raised by 19.02 percent.

Lastly comes the Sadar tehsil of Kanpur. This tehsil
has the lowest technological inputs as compared to all other
tehsils of Lower Ganga-Yamuna doab. Here net sown area has
decreased by 3.87 percent. And the area under paddy cultivation
has decreased by 0.92 percent. Its production has also
decreased by 12.84 percent and yield per hectare has decreased
by 12.05 percent. The decrease in production of rice is due
to the decrease in yield which is of cause a direct reflection
of low technological inputs. In case of wheat cultivation, area
under the crop has increased by 22.56 percent. Its production
46.32 percent and yield per hectare 22.93 percent.
Modern technology plays a very important role in the transformation of agriculture. In the early days our agriculture was of primitive type and it still persists in some parts of the country. The beginning of the 20th century was marked by awakening of interest in scientific study of agriculture throughout the world which had its implications in India as well. The Famine commission of 1880, 1898 and 1901, the Irrigation commission of 1903, the committee on cooperation of 1915 and the Royal commission on Agriculture in India, 1926, 1928 made many recommendations for the promotion of the welfare and prosperity of rural population.\(^1\)

The Reports of the Famine Commission were landmarks in the history of Indian agricultural development. However, it was the Royal Commission on Agriculture in India which practically paved the way for future research on the problems of Indian agriculture.

The Royal commission on Agriculture recommended the setting up of a central council for fastering and coordinating Agricultural Research throughout the country. The Indian

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Council of Agricultural Research was set up in 1929 to promote, guide and coordinate agricultural and animal husbandry research throughout India.² The Council performs the important task of coordinating agricultural research and framing agricultural policies for the country as a whole and also serves as an advisory body to the Government of India in matters pertaining to agriculture. Apart from India's Council of Agricultural Research, a number of commodity committees deal with research in respect to particular crops. These commodity committees are semi-autonomous bodies financed by grants from the Government of India, and are located in the main growing regions of the crops concerned.

Besides Agricultural Research Institutes, there are several agricultural universities and colleges which are scattered all over the country. They play a very important role in the extension and improvement of technology in agriculture.

In modern times effective and fruitful research cannot be done by isolated scientists in a large number of ill-equipped, ill-staffed, ill-coordinated and ill-supervised research stations scattered all over the country. Each research project has served interrelated aspects and its success depends on the

². Ibid.
provision of a team of highly qualified staff specialising in different fields. For example, general agriculture, soil and water management, agronomy, plant breeding, plant pathology, agricultural engineering, and marketing etc. close collaboration and coordination is necessary not among the various research stations in the state but also with other similar institutions.

Among the institutional changes that have over taken the Indian agriculture, land reforms occupy foremost position. It has been observed that the land reform introduced in the state have been responsible for a considerable improvement in agricultural situation in the state.

G.B. Jather and S.G. Beri pointed out that the most outstanding feature of backwardness of Indian agriculture is the endless sub-division and fragmentation of land. They describe the various causes of fragmentation and their evils which are responsible for the backwardness. They also proposed a number of remedial measures.\(^3\) Prof. Baljit Singh and S. Misra presented a comprehensive survey of all aspects of land reform in Uttar Pradesh. A brief account has been given on the basic purpose and objective of land reform.

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which is a cause of raising agricultural productivity and per capita income. They pointed out certain changes in which the area under cultivation including current fallows has increased more than 8 percent.  

According to United Nations Report (1951) the objective of land reforms are four, viz., maximization of output and productivity, fair and equal distribution of agricultural income, increasing employment opportunities and ethical order. The other United Nations Report on agricultural organization (1951) summarised the measure for reform of agrarian structure through a wide range of improvements in the organization of marketing and credit, the extension of educational and welfare services to the rural community measures for the re-organisation of production and cooperative farms.  

Nath pointed out the importance of land reforms development of cooperatives and expansion of infrastructure, viz., communication and rural electrification in the growth of agriculture.  

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Through consolidation, according to G. B. Jather and S. G. Beri (1949) land has become more productive. Areas formerly uncultivated owing to excessive fragmentation have been brought under the plough.  

A. Majumdar (1966) showed the impact of soil conservation programme on the agricultural economy of cultivators on the basis of a plot study of economic conservation Farming in Damodar Valley area conducted by soil conservation department of the Damodar Valley corporation in Hazaribagh district of Bihar. The study revealed, among other things the structure of land use and utilization before and after conservation treatment, cost of conservation treatment and maintenance, land and people benefited directly and indirectly by soil conservation programme.

W. S. Manu (1959) discussed the scope of consolidation of holding and conservation of their effects on agricultural production. D. P. Saxena and S. C. Sharma (1966) described the causes of soil erosion and the various measures of soil conservation that have been applied in Etawah in Uttar Pradesh.


A recent study by the Union of ministry of cooperation and Panchayati Raj provides detailed and exhaustive comments on the strength of cooperative in agriculture. Cooperatives have been contributing in several ways to the development of agriculture especially in the matter of distribution of loans and supplies of agricultural inputs. It ensures the balanced growth of production in which all sections of farming community can take their full share. Cooperatives help to get immediate requirement of both long and short term of loan to the farmers. Cooperatives have also supplied new varieties of seeds, fertilizers and implements and cash loan to the farmers. Cooperatives help farmers in marketing and other services.9

According to N.D. Rege (1969), the interrelationship that exist between soil, water and plants also the cultivation is important. Irrigation has been practiced in this country as a measure to overcome the deficiency of rainfall. The main objective is to get as assured crop by supplying some water to as many acres as physically possible during the period of drought. The modern concept of water management consists of more than just a supply of water to the field.10


According to K.L. Rao (1968) the two conditions for any large scale return from agriculture are land and water. They are ready means of increasing production.\(^\text{11}\)

N.G. Dastane and U.S. Patil studied the water requirements and presented in 1968 a detailed account in this respect. According to them water requirement of crops are essential for reaping potential yields. The present concept of water requirement is that it is the quality of water needed by a crop for obtaining maximum yield.\(^\text{12}\)

B.P. Pal in the year 1968 pointed out that overall production and yield per acre of irrigated land has not recorded the anticipated increase. Supply of water done not bring the desired impact. It is necessary that water and other inputs are used adequately and at right time without causing harmful residual effect on soil. To get the best result of irrigation, Indian council of Agricultural Research has realised the importance of this type of research.\(^\text{13}\)

According to S.C. Jain (1966), the basic component of new revolution in agriculture is mechanization. In the view of D.S. Sangwan (1966), the cause of low yield in


Indian agriculture is the lack of technical application in farms. According to them all the drawbacks are responsible for low yield can be removed by mechanical methods with low inputs.  

W.N. Bater in 1957 has suggested the way to introduce agricultural machinery and implements for crops to raise the agricultural output. But C. Culpin in the year 1959 has paid more attention to the organizational aspect of the machinery and their management on cooperative sense.  

J.S. Kanwar in 1970 has focused attention on the modernization of Indian agriculture. According to him the new technology of production is based on the use of fertilizers, high yielding varieties of seeds, pesticides, scientific water management and other agronomic practices. Now-a-days a greater use of machinery is made for seeding, fertilizer and pesticide application, harvesting, threshing and processing. In this way we see that suitable implements and machinery have become a necessity for the progress and modernization of Indian agriculture.

The Food and Agricultural Organization has published a series of books in which technological development and their implications to agriculture in various parts of the world has been discussed.

In one of the reports published in 1953, it has been stated that the introduction of machinery is more cheap than labour. Another report in 1955, presented a comprehensive outline of progress in technology for agriculture. However a more useful study has appeared in 1968. It deals with the problem of raising agricultural productivity in developing countries by applying modern technology. It covers all aspects of agricultural technology such as water management, irrigation, fertilizers, crop protection, application of machinery and other improved implements and institutional requirements, research extension and services, finance and agricultural credit supply in time.

G.K. Chadha in 1977 pointed out that in recent years, significant changes have occurred in agricultural technology of India. According to him the new agricultural technology consists of biochemical and chemical innovations.

Biochemical innovations are the gift of science and refer mainly to inputs which have a physiological effect in increasing productivity from a given land base. High yielding varieties of seeds, chemical fertilizers, pesticides etc. are examples of such innovations. Mechanical innovations are the gift of engineering and refers mainly to inputs which have a physiological effect in increasing timeliness of field operations. While biological innovations are generally labour displacing and biased to scale.

A. Singh in 1970, has given a formula to calculate the percentage of pure living seeds in a sample. All seeds require adequate oxygen and moisture and a favourable temperature to germinate. Suitable temperature is critical factor in the germination of seeds.

R.S. Mathur in the year 1969, has discussed plant diseases in a lucid style. He provides the latest informations on the control of plant diseases. According to his estimate more than Rs. 400 crores of our National income is lost annually due to the plant diseases caused by fungi, bacteria, nematodes and viruses. In order to overcome this available deficit the fight against them is very necessary. He

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suggested use of high yielding varieties of seeds and seed treatment with organomercury compound as a control of a number of seed born diseases.  

Pradhan (1969) described the wastage and reduction of agricultural production caused by insects and pests. He gives detailed description of a total of 62 pests species which are common to several crops.

According to S.S. Khanna and V.K. Mital (1970), about 85 species of insect pests were recorded in rice fields causing substantial losses in yield in Uttar Pradesh. They suggested a number of control measures of insects and pest in rice. Eradication of plant diseases is essential for agricultural progress.

B.S. Minhas and V. Nathan (1965) have explained the inter-state and intra-state variations in output in terms of variations in the extent of variable culturable area and per hectare yield. The Government of India has also conducted several studies on inter-regional and intra-regional variations and inter-state and intra-state

variations in crop output on the basis of the model presented by Minhas and V. Nathan. 24

According to S.K. Rao (1971), the major cause of inter-state variations in crop output is the difference in the growth of irrigated area among the state. 25

S. Bhalla (1977) suggested that increase in agricultural output is due to the improvement in infrastructure, the acreage structure of land holdings and institutional factors. He concludes that the variation in output growth is due to the lack of various inputs of technology. 26

Noor Mohammad pointed out that technological change in agriculture consists of adoption of farming techniques developed through researches and calculated to bring out diversification and increase in production and greater economic return to the farmers. The use of fertilizers, improved varieties of seeds, pesticides, fungicides, improved


irrigation facilities, new agricultural implements and contour bunding for the conservation of moisture and soil are some of the examples of such techniques.  

Oammen (1966) has suggested that the term technological change is used here in a broad sense to include all kinds of innovations and inventions aimed at increasing the efficiency of agricultural production. Changes in the techniques of farming as well as breeding and feeding of livestock are also included in it.

Banerjee (1969) suggests that the future of the Indian agriculture depends on the adoption of an adequate strategy in agricultural planning based on a comprehensive assessment of the agricultural resources potentiality, its social and economic infrastructure, and their possible impact on the country as a whole.


A.C. Sharma pointed out that agricultural development should be assessed not only by levels of productivity or trends in agricultural production but also with reference to various physical inputs like irrigation, fertilizers, improved seeds, and extent of cultivated area.  

The area of Lower Ganga-Yamuna doab is very fertile. Inspite of the fertility of the soil, the yield per unit area is not satisfactory. It varies from place to place on a large scale. Therefore the study of agriculture and its transformation is very essential for a region which have high degree of variation in agricultural inputs and production. Generally the agriculture is transformed by the use of input of different nature. Of these, technological and institutional factors plays a vital role in transforming the agriculture which is reflected in agricultural output. In certain areas where the agricultural inputs are high but the net output is low, the area is not said to be agriculturally well developed as compared to those areas where inputs are relatively low but net output is fairly high. In this regard the appropriate agricultural inputs are needed to get maximum products in order to make the agriculture highly transformed. Lower Ganga-Yamuna doab is a region facing these problems. Therefore, this area is selected as a case area for the proposed Ph.D. work. This work will be based on the data obtained from the directorate of Agriculture, U.P. Lucknow, and census of India publication.
There are a number of indicators of agricultural transformation. The indicators which support or may support the agricultural transformation of the Lower Ganga-Yamuna doab are listed below:

1. Intensity of agricultural inputs.
2. Index of agricultural productivity.
3. Diversification of cropping.
5. Net irrigated area as percent to net sown area.

The spatial pattern of these indicators based on tehsil level data of this area will be studied. This pattern will reveal the degree of variations and the role of technological and institutional factors among these variations will be examined. The chief technological and institutional factors that are proposed to be studied are:

(a) Technological variables

i) Modern agricultural machinery and implements

ii) Use of chemical fertilizers

iii) High yielding varieties of seeds

iv) Irrigation

v) Mechanization in agriculture

vi) Use of pesticides and control of diseases
(b) Institutional variables:
   i) Land consolidation
   ii) Credit supply
   iii) Cooperative society
   iv) Sub-division and fragmentation of holdings
   v) Land tenure and land revenue.
   vi) Size of the land holdings
   vii) Extension services.

These factors play a very vital role in the transformation of agriculture of the lower Ganga-Yamuna doab.

A number of techniques has been developed for the geographical study of the phenomena but the three techniques Correlation, multiple regression and principal component analysis may be applied to test and to analyse the hypothesis. Correlation techniques which may be helpful in the study of regional variations of the indicator of agricultural transformation are found here to exist in complex interconnections with institutional and technological variables. Among these three techniques i.e. Kendall's technique of ranking coefficient, product momentum correlation and rank difference correlation are important.
In the present work Kendall's simple technique of ranking coefficient has been used to determine the input and output efficiency so that lower the coefficient the higher the efficiency.

Product momentum correlation is expressed as:

\[ r = \frac{\sum xy}{\sqrt{\sum x^2 \cdot \sum y^2}} \]

The rank correlation coefficient (\( \rho \)) is obtained from the equation:

\[ \rho = 1 - \frac{6 \sum d^2}{n(n^2 - 1)} \]

where \( d \) refers to rank difference of the two variables and \( n \) refers to the number of observation. Both techniques may be tested for significance with the of 't' distribution which may be obtained from the following equations:

\[ t = r \sqrt{\frac{n-2}{1-r^2}} \]

and \[ t = \rho \sqrt{\frac{n-2}{1-\rho^2}} \]

The second techniques, i.e., multiple regression provides the linear relationship between one variable and a number of others. This may be expressed as:

\[ Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots \ldots \]
where \( y, x_1, x_2, x_3 \) are the variables and 'a' is the constant and \( b_1, b_2, b_3 \) are coefficients.

The third technique, i.e., principal components analysis is a measure of reducing the number of variables taken from multivariate data. These sets of reduced variables may be used to describe the variations as observed in the original data.

In brief, component analysis discovers as to how much of the total variability exhibited by the primary variables can be accounted for by a smaller number of new independent variables of the principal components. The analysis involves an orthogonal transformation of a set of variables \((X_1, X_2, \ldots, X_m)\) into a new set \((Y_1, Y_2, \ldots, Y_m)\). The transformation may result in \((Y_1, Y_2, \ldots, Y_m)\) being uncorrelated one with another, notwithstanding the fact that the original variables \((X_1, X_2, \ldots, X_m)\) may have been quite highly intercorrelated.\(^1\)

There are many components derived as there are variables, and the original total variance associated with \(X_1, X_2, \ldots, X_m\) is preserved exactly in the total variance of the components \(Y_1, Y_2, \ldots, Y_m\). The solution, is such that \(Y_1\) accounts for

the highest proportion of the variance, $Y_2$ for second largest share, and so on, called as first principal component, second principal component and so on.

The first principal component is a linear combination of all the different variables taken as a meaningful indicator of the agricultural transformation of the region. The variance of this first principal component which will be maximum of all the variance of this component.
Transformation of agriculture depends on continuous economic adjustment of farm organisation by absorbing improved technological innovations and institutional cooperation on a profitable basis. The process of agricultural transformation has already begun and the recently introduced institutional reforms and adoption of modern technology are paving way for large scale agricultural transformation. The farmers are fully conscious of the fact that agriculture can be transformed only by using improved varieties of seeds, chemical fertilizers, better and profitable use of water, improved agricultural implements and following crop protection practices. Much attention has recently been focused on agricultural transformation to remove the regional imbalance in different parts of the study region.

In the present study it is found that tehsilwise distribution of modern agricultural technology is not uniform throughout the study region. Some tehsils are having higher technological inputs while the others are having lesser technological inputs. Further study reveals that relationship between modern agricultural inputs and area, production and yield of crops are not true. In some tehsils the technological inputs are much higher but the yield of the crops in the tehsil is much low and vice-versa. This shows that there are some socio-economic and pedo factory which acts as hinderance in the uniform transformation of agriculture in the lower Ganga-Yamuna doab.
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