INTRODUCTION
The task of feeding the rapidly growing population, maintaining the socio-economic stability, generating employment opportunities and improving the standard of living of the rural masses are some of the challenges which India is facing today. India is predominantly an agricultural country where about 77 per cent of its population still lives in rural areas and directly or indirectly depends on agriculture for its livelihood. India has taken big strides in agricultural production but the increase in production has been washed out by rapid growth in population. The major problem of the Indian agriculture is that it is predominantly of subsistence type. Food is a perennial problem and the rural masses are backward and poverty stricken. All attention should be diverted to increase the food production and ameliorate the lot of rural masses.

To solve the food problem and bring prosperity to the rural masses, a great need arises to increase our agricultural production. Food production could be increased in two ways, first by bringing new lands under plough and secondly by increasing the yields from the lands already under cultivation, yields could be increased only by scientific means. Hence, it is now realized that the development of Indian agriculture depends on its adaptability to technological change - a change in the parameter of production-function resulting directly from the use of new knowledge. The tech-
nological change in agriculture consists of adoption of farming techniques developed through research and calculated to bring out diversification, increase in production and greater economic returns to the farmers. Technological change is the key to rapid rate of growth. The proper combination of various improved technological factors, i.e., ensured agricultural innovations, use of fertilizers, high-yielding variety of seeds, modern agricultural machinery and implements, pesticides, irrigation and various other farming techniques, should certainly result in better yield and higher production.

The developments in Indian agriculture, adopted since the mid sixties, have been variously designated. Some people call them a 'technological breakthrough', while others call them 'Green Revolution'. Whatever the name, the fact remains that they have come to be regarded as an important landmark in the history of agricultural development in India. India is replacing the primitive and traditional system of agriculture and applying new technology to transform agriculture into completely new trends. The process of development has already begun and the recently introduced Integrated Rural Development Programmes (IRDP—launched in 1978-79) are paving way for the application of technology.

Due to a very large proportion of population living in villages, rurality has become the spinal cord of socio-economic, political and cultural life of India. During the
first quarter of the present century, it was realised that if the poverty of India's teeming millions is to be reduced, more attention had to be given to rural areas which are characterized by poverty, illiteracy, ignorance, dirt, disease, low level of production largely due to primitive methods of production, lack of resources for improvement or development and a very low rate of employment. Social and community life often in a state of disintegration and decay and a very low percentage of rural people are able to take advantage of science and technology because they have neither resources nor adequate knowledges. The hard core of rural poverty and backwardness comprises of the marginal farmers, agricultural labourers (about 50 per cent of whom are landless), rural artisans and fishermen. These sections possess little or virtually no assets. As a result, there is stagnation in the social and economic life of the rural community. Therefore, the development of rural areas has been one of the basic objectives of Indian Government. The rural people need to be enabled to acquire productive assets and/or appropriate skills and vocational opportunities and then backed effectively with services to increase production and productivity. Though many efforts have been made to improve the conditions of the rural masses, the sky remains overcast with few blue patches of development. Various reasons such as limited resources, inadequate exploitation of local resources, sectoral approach in planning, incompetent
implementing agencies, urban bias in development and the neglected socio-economic structure are attributed to failure of development programmes. The social aspects of the rural people have got great bearing on the fruitful implementation of new technology and consequently on the rural development.

One of the objectives of the development of agriculture is to improve the living standards of the people in the rural areas. Social justice and equality of opportunity are the cornerstones in the development strategy. There are certain regions, in the country, which are relatively affluent and the farmers are well to do, while there are other regions in which the rural population inspite of hard work lives in an abject poverty. It is therefore, appropriate to delimit the areas which suffer from low agricultural productivity and measures be suggested to remove the regional imbalances. The rural population of India in general and of areas that lagged behind in development in particular, should make efforts to step up agricultural production and ensure that the new technology is more widely used.

The community Development Programme (started as early as 1952) aimed to bring about an overall development, but the programme did not respond to the specific task assigned to it in the field of agricultural development. The services that were provided went largely to the more well to do sections of the rural community. Then came the Intensive Agricultural
District Programme (IADP-launched in 1961-62) also known as 'Package Programme' containing technical know-how, credit and production supplies for stepping up agricultural production. Subsequently the Intensive Agriculture Area Programme (IAAP) and High-Yielding Varieties Programme (HYVP) was launched with the basic objective of increasing production quickly.

The primary objective of agricultural development is usually the increased growth of agricultural output, the main aim of rural development is the improvement of the material and social welfare of the rural population. Although not usually intended, rich farmers tend to gain most from development efforts as they have easy access to education, credit, market, irrigation and other facilities in contrast to those at the other end of the scale. This has led the World Bank and other donor agencies and countries to give increasing attention to the needs of poor, mainly small farmers. Serious difficulties stand in the way of implementing such rural development programmes. The real help consists of providing provisions for infra-structural facilities, which is essential for sustained development but are not paying in the short-run. Thus the poorer lot is unable to take advantage of these facilities. Government may provide water supply, drainage, roads, buildings and other facilities at little or no cost to rural people but is cannot be
expected to operate and maintain this rural infra-structure indefinitely. There are many instances where it has been seen that the Government has spent considerable sums to provide social infra-structure in rural areas and have ended up with schools without teachers, clinics without doctors and chronic unemployment and under employment.

OBJECTIVES:

In the present work an attempt has been made to study the "Role of Technology in Agricultural and Rural Development of Aligarh District since 1960". Aligarh district was selected as the study area because it is one of the agriculturally advanced districts of Uttar Pradesh. According to a study (Mitra, 1961), Aligarh was one of the ten districts of Uttar Pradesh which qualified for the highest level of development. This district was selected for the Intensive Agricultural District Programme (IADP) in 1961-62 with a view to accelerate the food production by compounding all the requisite inputs and to demonstrate to the farmers the most effective methods of increasing agricultural production with the help of latest farm technology.

The present study has certain specific research objectives:

1. To assess the growth of crop output and to analyse the contribution of different component elements, i.e., area growth, yield effect, changes in cropping pattern and interaction between yield cum cropping pattern, to this growth in the different blocks.
2. To identify the inter-block variations in agricultural development seven technological indicators were considered.

3. To attempt to identify the factors, including specific technological inputs - irrigation, fertilizers, high-yielding variety of seeds and use of implements, causing variations in yield in the different blocks.

4. To identify the inter-block variations in rural development twelve indicators representing socio-economic infra-structural facilities were considered.

5. To attempt to identify the factors, including specific socio-economic infra-structural facilities causing variations in rural development in the different blocks.

6. To identify the block-wise level of overall development nineteen indicators representing seven technological factors in agricultural and twelve socio-economic infra-structural facilities in rural development were considered.

7. To assess the possible inter-relationship between agricultural and rural development, agriculture and overall development, rural and overall development on block-wise bases.

8. Based on this study planning regions for overall development of the district has been delineated.

   Aligarh district has made satisfactory progress on agricultural front, quality of life of rural masses has
improved and the signs of overall development are visible unmistakably. We attribute this progress to adoption of technology in agriculture and other walks of life. We hypothesized that "it was technical breakthroughs which had caused rapid increase in agricultural production which in turn, had led to self-sustaining rural development". These assumptions have been tested in the present work and found to be substantiated. Our focus has been to undertake a micro-level study of Aligarh district and whenever possible administrative blocks of the district has been taken as units in our study. Since our study is from 1960, district level published data were available from 1960 onwards whereas published data for the seventeen blocks were available from 1974 onwards, so block has been taken as the unit of our study from 1974 onwards.

**SELECTION OF INDICATORS**

1. The levels of agricultural development has been measured in terms of technological factors employing seven indicators, i.e.,

   (i) Yield per hectare
   (ii) Proportion of gross irrigated area to gross cultivated area.
   (iii) Consumption of fertilizers kg. per hectare
   (iv) Proportion of number of implements to gross cultivated area.
(v) Proportion of area under high-yielding variety of seeds to gross cultivated area.
(vi) Percentage of gross cultivated area to net sown area.
(vii) Percentage of gross irrigated area to net irrigated area.

2. In the analysis of the factors affecting variations in yield:
   (i) Yield per hectare has been taken as the dependent variable
   (ii) Explanatory variables are irrigation, high-yielding variety of seeds, fertilizers and use of improved implements.

3. The levels of rural development has been measured in terms of socio-economic infra-structural facilities employing twelve indicators, i.e.,
   (i) Educational facilities per 10,000 population
   (ii) Health services per 100,000 population
   (iii) Banking facilities per 100,000 population
   (iv) Per capita distribution of loans by different society
   (v) Capacity of storage in metric tonnes
   (vi) Bio-gas plant facilities per 100,000 population
   (vii) Percentage of markets/hats (local village markets) to total villages
(viii) Percentage of village electrified
(ix) Transportation facilities per 100,000 population
(x) Communication facilities per 100,000 population
(xi) Agricultural implements service centres per 100,000 population.
(xii) Percentage of village having drinking water facilities

4. For measuring overall development, the sum of all the indicators used for measuring agricultural and rural development, i.e., 7+12 = 19 indicators have been used.

DATA BASE:

This study is the outcome of field work done by the writer during the years 1984 to 1986. The data were collected both from the primary and secondary sources.

Data from secondary sources have been calculated principally from various bulletins:


(iii) Agricultural Prices in India (from 1960 to 1986),
published by Directorate of Economics and Statistics,
Ministry of Food and Agriculture, Government of India,
New Delhi.
(iv) Crop and Season Reports (from 1960 to 1986), published
by Directorate of Agriculture, Lucknow.
(v) Data were collected from Project Office, Kuarsi Farm,
Aligarh.

Data from primary sources have been collected through
(i) field surveys, (ii) interview with farmers and patwaris
(village accountants), (iii) discussions with the Government
officials of the Integrated Rural Development Programme at
Aligarh, (iv) discussions with the officials of the project
office, Kuarsi Farm at Aligarh and (v) discussions with the
officials from rural education, health, banks, transport and
agricultural implements service centres.

District level published data were available from
1960 to 1985 whereas published data for the 17 blocks of
Aligarh district were available only from 1974 to 1985.
Therefore, all the analysis has been done for the Aligarh
district as a whole from 1960 onwards and for the 17 blocks
from 1974 onwards. Some data have been manually calculated
while others through computer.
METHODOLOGY:

The following statistical methods have been used in the present study:

1. The contribution of different components to the growth of crop output was estimated with the help of four factor model developed by Minhas and Vaidyanathan (1972). The notational representation of the data is as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Weight</th>
<th>Proportion of area in year</th>
<th>Yield in year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>t</td>
</tr>
<tr>
<td>$C_1$</td>
<td>$W_1$</td>
<td>$C_{10}$</td>
<td>$C_{1t}$</td>
</tr>
<tr>
<td>$C_2$</td>
<td>$W_2$</td>
<td>$C_{20}$</td>
<td>$C_{2t}$</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>$C_n$</td>
<td>$W_n$</td>
<td>$C_{no}$</td>
<td>$C_{nt}$</td>
</tr>
</tbody>
</table>

where $C_i$s = Crops, the analysis is only concerned with ten major crops of the district

$W_i$s = Constant price weights assigned to different crops and consists of three year average of wholesale prices.

$C_{i0}$...$C_{it}$= Proportion of area occupied by different crops in year 0 and t, the representation of crops pattern which is three year average on each end.
Yio .... Yits = Are base and final year yields, these are also three year average on each end.

Definitions:

\[ Po = AO \sum_i Wi \times Yio \]
\[ Pt = AT \sum_i Wi \times Cit \times Yit \]

where \( Po \) = Crop output in year 0
\( Pt \) = Crop output in year \( t \)
\( Ao \) = Gross crop area in year 0
\( At \) = Gross crop area in year \( t \)

Assuming that every new gross crop hectare is as good as an average hectare already under cultivation the increases in crop production over the time period of this study was split into their component elements:

\[ Pt - Po = (At - Ao) \sum_i Wi \times Yio \]
\[ + At \sum_i Wi \times Yio (Yit - Yio) \]
\[ + At \sum_i Wi \times Yio (Cit - Cio) \]
\[ + At \sum_i Wi (Yit - Yio) (Cit - Cio) \]

Of the four component elements, the (i) element is the area effect i.e. increases in output could have taken place in the absence of any change in per hectare yield and crop patterns. The (ii) element is the effect of yield changes for a constant crop pattern. The (iii) element is the effect of changes in crop pattern in the absence of any changes in per hectare yield. The (iv) element is the inte-
raction between per hectare yield changes and the changes in crop pattern. The component element are so chosen that their contribution to crop output is determined by more or less independent set of factors and each of them could be analysed separately.

2. For measuring the relative contribution of various attributes of agricultural (7 indicators) and rural (12 indicators) development, in the seventeen blocks of Aligarh district, standard score technique was applied (Z score):

\[
Z_i = \frac{X_i - \bar{X}}{SD}
\]

where 
- \(Z_i\) = Standard score for the ith observation
- \(X_i\) = Original value of the observation
- \(\bar{X}\) = Mean for all the values of \(X\)
- \(SD\) = Standard deviation of \(X\)

Further the results of the standard score obtained for different indicators, were aggregated by composite standard score so that the disparities in the level of development of blocks were obtained on a common scale. The composite standard score was explained as (Smith, 1975):

\[
T_j = \frac{1}{m} \sum_{i=1}^{m} Z_{ij}
\]

where
- \(j\) = the blocks
- \(m\) = set of indicators
- \(Z_{ij}\) = Standard score of the ith to jth indicators
In order to classify the blocks, according to the magnitude of development, the composite standard scores were divided into three classes:

<table>
<thead>
<tr>
<th>Class</th>
<th>Range of composite score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High</td>
<td>&gt; + 1.0</td>
</tr>
<tr>
<td>2. Medium</td>
<td>+ 1.0 to -1.0</td>
</tr>
<tr>
<td>3. Low</td>
<td>&lt;= -1.0</td>
</tr>
</tbody>
</table>

3. Taking yield per hectare as a dependent variable, a step-wise regression technique has been used to identify the important variables causing variations in yield. The technique for step-wise regression used in the study involves the following steps:

(i) The step-wise regression analysis involved adding one independent variable at a time and generating a series of intermediate regression equations. The first independent variable considered was the one which had the highest simple correlation with the dependent variable. This initial two-variable regression was completed, and then the partial correlations between the dependent and all the other independent variables were computed.

(ii) In the second step, the independent variable among these which had the highest partial correlation, in other words, the one which contributed most to the unexplained variation in the dependent variable
remaining after the first regression, was then included in the second step. A new regression equation now involving two independent variables was derived; the partial correlations were computed for the remaining variables with the two held constant; and the selection of the next variable to be included was made on the basis of these values. At each step, the adjusted partial regression co-efficients and multiple correlation co-efficients were also obtained. The step-wise procedure continues until all the specified independent variables were included.

Thus, whenever a multiple regression analysis is attempted, it is useful to know as to how the parameters get changed when new variables are added, one by one, in the model. This procedure helps in many ways. Firstly, it shows the contributions of an added variable in explaining the dependent variable (by seeing the changes in the value of $R^2$). Secondly, it helps to see whether the new variable is worth including in the model or not (by seeing the changes in the value of $R^2$). It also helps us in keeping a watch over the changes in the values of the regression co-efficients and their standard errors.

The present work is divided into two parts spread over six chapters.

Part one comprises of chapter I and chapter II. In this part an evaluation of the study area has been done.
Chapter I makes an attempt to analyse the physical features, drainage and climate of the district and how these factors have helped in the development of agriculture in Aligarh district. Chapter II is devoted to the examination of the agricultural background of the district. Here an assessment is made of the agricultural conditions in the Pre and Post Green Revolution Period and the nature of change that took place.

Part two presents the crux of the problem investigated. This section comprises of chapter III, IV, V and VI. Chapter III is devoted to the block-wise assessment of growth of crop output and analysis of the contribution of the different component elements to this growth. Chapter IV deals with the inter-block variations in agricultural development. An attempt is also made to study the factors affecting variation in yield in the different blocks. Chapter V elucidates the components of rural development. It also deals with the inter-block variations in rural development and tries to assess the factors affecting variations in rural development. In Chapter VI, an attempt has been made to identify the levels of overall development in the various blocks of the district. Inter-relationship between the block-wise levels of agriculture and rural, agriculture and overall and rural and overall development is sought to be made. Based on the results obtained regions were delineated for planning purposes for overall development of the district.