INTRODUCTION

Agriculture continues to be the key industry in the world even in the 21st century. It is not only the dominant form of employment but also the basis for a way of life for, perhaps, two-thirds of the world's households. Agriculture is a world-wide activity. It is practiced in the developed and developing societies of the world. Physical factors like relief, temperature, frost, moisture, sunshine, wind, soil profile and its chemical composition, soil fertility, salinity and alkalinity of soil etc. affects agriculture of a region. In addition to the physical factors, it is also governed and largely influenced by the socio-economic factors like religion, caste, culture, traditions, customs, belief, education, income, ownership of land, size of farm etc. and institutional and technological factors like availability of credit and regional rural banks, Panchayati Raj system, use of high-yielding variety of seeds, irrigation facilities, use of fertilizers, tractors, threshers, ploughs and cold storage facilities. Agriculture is not merely a profession in India. It is the spine of rural living and has influenced the progress of our civilization. Agriculture is the economic backbone of India, contributing about 25 per cent of the gross domestic products. Agriculture engages about 70 per cent of the total population, out of which 43.34 per cent are cultivators and 26.33 per cent are landless labourers. Indian agriculture not only feeds the teeming millions of people but also provides raw material to many of the agro-industries, and thus has a dominant role in its export performance. The overwhelming importance of Indian agriculture thus cannot be over emphasized.

Indian agriculture was organized, traditionally, not as an industry but as an activity for marginal subsistence of the bulk of the population. Consequently the farmer's motivation by and large was not to create massive agricultural surpluses for supporting other modes of economic activity but merely to produce enough to satisfy the minimum requirements of the enormous population dependent on agriculture. As long as excess population was wiped out by famine, disease and infant mortality, there was no strong reason for change in the traditional attitude towards subsistence agriculture. Large investment in time or money was not required to create the bare surplus from land. In the circumstances, agriculture was naturally the preferred economic activity as long as there was no dearth of land and population was under reasonable control through natural though unfortunate causes. The production per
hectare in the subsistence farming was low and under the increasing pressure of population the growing demand for food and raw material for the agro-industries the subsistence farming could not provide even the bare food to the people. The problem of poverty, servitude, low level of productivity and social tensions got accentuated. The small farmers began to dispose of their tiny holding and many of them moved in the urban areas to start a new way of life. About 48 per cent of the total area of the country is under cultivation which is quite high when compared with the other countries of the world yet only 0.15 hectare of land is available to support one person dependent on land. The frontiers of arable land in fact has already been pushed almost to the limit and bringing of new areas under cultivation is very difficult if not impossible. Moreover, any further encroachment on the forest land and other categories of land may disturb the precarious ecological equilibrium which can result into more droughts, floods and changes in the climatic conditions.

The solution of the problem, therefore, does not lie in the expansion of agriculture on the new lands but in intensification of the crop land use by adopting the new technology. In order to achieve this objective a massive programme was launched a new agricultural strategy, known as the ‘package programme’ was adopted. The new agricultural strategy adopted in the mid-sixties have brought some significant changes in the cropping structure, cropping patterns, crop combinations, crop concentration and diversification have gone under transformation. The adoption of new agricultural technology brought massive changes in the yield of wheat and rice in Punjab, Haryana and some districts of western Uttar Pradesh. The emergence of new cropping patterns have created the problem of regional imbalances, ecological and environmental problems, landuse changes and social institutions of natural cooperation.

Statement of the Problem

Agriculture occupies an important position in Indian economy. Its contribution to the national income in 1950-51 was upto 54 per cent which declined to 30 per cent in 1994-95 and 23 per cent in 2005-06. Agricultural output in India determines not only the per capita income of farm sector, it also influences the standard of living of rural population and the nutritional standard of the poor masses. The share of agriculture in gross domestic product (GDP) in India is about 22 per cent in 2005-06.
It provides food, fodder and raw materials and thus contributes to overall economic growth. Its good performance over the period of time helps in the generation of more employment, thereby reducing poverty, hunger and malnutrition. The rapid economic development of any state or region without the development of its agriculture is almost impossible. Keeping in view the importance of agriculture there is a need of through discussion regarding the problems of Indian agriculture in general and of Rohilkhand plain in particular. The growth rate of national income jumped to about 4 per cent between 1950-51 and 1991-92 but the agricultural production rose only by about 2.8 per cent per annum. Foodgrain production has increased from 51 million tones in 1950-51 to 210 million tones in 2006-07. Yet the scenario today is not so promising. In recent years, growth has plummeted and is around 2.7 per cent as against the growth target of 4 per cent.

When we compare India with China two countries were more or less on a par on most parameters of agriculture 25 years ago. China’s has been steadily growing at between 4 and 5 per cent over the last 15 years. By 2005, China had in fact emerged as the world’s third largest food donor. The two widest agriculture related discrepancies between India and China lie in the diverging productivity levels of various crops. According to the Food and Agricultural Organisation (FAO), the average yield of rice in India between 2003 and 2005 was 3,034 kilograms per hectare. In contrast, the comparative figure for China was more than double at 6,233 kg/ha. For wheat corresponding figures were 2,688 kg/ha for India compared to 4,155 kg/ha for China. The data on the trend rise in yields in the 15 years leading upto 2005 are also felling. For rice the trend rise over this period in India was only 1 per cent, less than half of China’s 2.1 per cent. According to statistics from the International Rice Research Institute, India produced 124 million tones of rice compared to China’s 186 million tones in 2004, despite having almost double the area under paddy cultivation (42 million ha. Vs. 28 million ha.).

Other crops such as wheat and groundnut reveal similar trends, with China well in the lead. The widest divergence between India and China, however, is in the profitable horticultural sector with the production of fruits and vegetables in China leaping up from 60 million tonnes in 1980, roughly comparable to India’s 55 million
tonnes at the time, to 450 million tonnes in 2003, way ahead of India's corresponding 135 million tonnes.

In India foodgrain production has increased from 51 million tones in 1950-51 to 210 million tones in 2006-07. Yet, the scenario today is not so promising. In 2005-06 growth has plummeted and was around 2.7 per cent as against the growth target of 4 per cent. This is a matter of concern. To sustain an economic growth of 9 per cent plus, and reduce poverty on a long term basis, we need to achieve agricultural growth of at least 4 per cent annually. This is going to be a formidable challenge that we have to face and overcome.

With the population explosion, cultivable land has become deeply fragmented. The average size of operational holdings for cultivation decreased from a little more than 5 hectares during the 1950s to as small as 1.41 hectares during the 1990s. Out of the 70 million holdings in the country, 64 million (92 per cent) are wholly owned and self cultivated, 3 million holdings are partly owned and partly rented, and another 3 million are wholly leased in and account for 4 per cent.

This shows that marginal holdings account for 50 per cent of the holdings of the country (30 million operational holdings) but only cover 9 per cent of the area (about 15 million hectares). Small holdings account for 20 per cent of the holdings (14 million holdings) and cover about 13 per cent of the area (19 million hectares). Thus marginal and small holdings taken together account for 70 per cent of the total holdings, but cover only 21 per cent of the cultivated area. Small and medium holdings constitute 15 per cent of the total holdings but cover 18.5 per cent of the operational area, while medium-sized holdings account for 11 per cent of the holdings with 3 per cent of the total area. It follows that 26 per cent of the holdings account for 48.5 per cent of the operational area. It is important to note here is that 4 per cent of the large holdings (10 hectares and above) cover 30.5 per cent of the operated area.

It is thus obvious that the concentration of the land in the hands of the affluent farmers continues to be intact. Such uneconomical size of available farmlands forced many farmers to abandon farming. The number of marginal holdings has increased from 3.5 crore to 7.10 crore over last three decades. Today, there are about 7 crore farmers with holdings of a meager 1 hectare or even less. It is, therefore, not surprising that many small land holdings are becoming economically unviable,
making the small and marginal farmers live in perpetual debt. The large number of suicides reflects the overall plight of these farmers.

In a country like India where agriculture is the mainstay of the majority of the population and is in such a bad conditions the researches in this field becomes quite decisive. The level of agricultural development achieved in various political-cum-administrative subdivisions finally determines the socio-economic development of that particular region. Keeping in view the importance of micro level researches Rohilkhand plain comprises of eight districts namely Bareilly, Badaun, Shahjahanpur, Pilibhit, Bijnor, Moradabad, Rampur and J.P. Nagar has been selected as the study area. It is almost a leveled plain having more or less homogenous physical and cultural characteristics. Majority of the population is dependent on agriculture and the magnitude of socio-economic development depends on it.

Study area

The Rohilkhand plain lies in the north-western part of the state of Uttar Pradesh between latitude 27°35' to 29°58' N and longitude 78° to 80°27'E. Rohilkhand region shares its boundary with a newly created state of Uttaranchal and Nepal in the north. Rohilkhand plain comprises the districts of Bareilly, Budaun, Shahjahanpur, Pilibhit, Bijnor, Moradabad, Rampur and J.P. Nagar. It covers an area of 30,544 sq.kms. of north-western Uttar Pradesh having a total population of about 23.6 millions with density of 642 persons per sq.km (in 2001). The whole Rohilkhand region forms a part of the Indo-Gangetic plain.

Objectives

The main objectives of the study are:

(i) To ascertain the changes in cropping intensity and crop combinations in time and space.

(ii) To explain the landuse organization as a consequences of the spread of new agricultural technology with special reference to the changes in cultivated area, production and yield.

(iii) To delineate the productivity regions to establish causal relationship with variable factors of production in different productivity regions, and suggest remedial measures for the improvement in productivity.
(iv) To find out the causal relationship among different variables of agriculture and socio-economic development to know the regional disparities in Rohilkhand plain.

(v) To know the influence of new cropping practices on farmers.

(vi) To know the impact of agricultural changes on the socio-economic development of the people of Rohilkhand plain.

Hypotheses

The study is primarily concerned with agricultural changes and socio-economic development in which following hypotheses are to be tested.

(i) The use of new agricultural technology leads to positive changes in cropping intensity which leads to overall agricultural development.

(ii) The farmers of Rohilkhand plain are moving from subsistence farming to the market oriented farming and from multicropping to monocropping pattern.

(iii) Agricultural development leads to socio-economic development.

(iv) New cropping practices leads to positive changes in the agricultural incomes of the farmers but leading to many environmental and social problems.

Database and Methodology

The present study is based on primary as well as secondary sources of data. The secondary data for three different periods i.e. 1985-90, 1991-96 and 1997-02 were collected from the published records of the Directorate of Agricultural Statistics and Crop Insurance, Krishi Bhawan and the Institute of State Planning, Jawahar Bhawan, Lucknow, U.P.

The primary data were collected with the help of a questionnaire prepared covering various aspects of agriculture and socio-economic development in rural areas. A comprehensive household survey in thirty seven villages (1 village from each Tehsil) of eight districts of Rohilkhand plain was conducted during the months of Feb. and April 2007 based on simple random sampling. From every village 10 per cent households were taken as samples.
The study is divided into three periods i.e. 1985-90, 1991-96 and 1997-02. Districtwise cropping intensity is calculated by using the formula:

\[
\text{Cropping Intensity} = \frac{\sum a_{ij}}{\sum a_{i0}} \times 100
\]

where

\[a_{ij} = \text{area under the ith crop in the ith year}\]
\[a_{i0} = \text{area under the ith crop in the base year}\]
\[N_j = \text{net area shown in the jth year}\]
\[N_0 = \text{net area shown in the base year}\]

Crop combination regions were determined by applying Weaver’s minimum deviation method, which would be read as follows:

\[SD = \sqrt{\frac{\sum d^2}{n}}\]

where

\[d = \text{differences between the actual crop percentages in a given areal unit and the appropriate percentage in the theoretical curve}\]
\[n = \text{number of crops in a given combination}\]

Crop combination regions also calculated by applying Doi’s method which substitutes Weaver’s method of \(\sum d^2/n\) with the sum of square differences \(\sum d^2\). The combination having the smallest \(\sum d^2\) will be the combination of primary crops. It is not required to calculate \(\sum d^2\) for each combination but it can be discovered by constituting a one-sheet table which Doi himself provided.

Spatial patterns of growth in area, production and yield of major crops computed by applying linear regression technique. The crop-wise linear growth rates (in order of increase or decrease or static position) for each district in area, production and yield were computed for the corresponding periods viz. 1985-90, 1991-96 and 1997-02.

An assessment of agricultural productivity is made to find out high, medium and low productivity regions based on Bhatia’s formula as follows:
where

\[ I_{ya} = \text{is the yield index of crop } a, \]
\[ Yc = \text{is the average acre yield of crop } 4 \text{ in the component unit, and} \]
\[ Yr = \text{is the average acre yield of crop } a \text{ in the entire study area.} \]

and,

\[ Ei = \frac{I_{ya}.C_a + I_{yb} + \ldots + I_{yn}.C_n}{C_a + C_b + \ldots + C_n} \]

where \( Ei = \text{is the agricultural efficiency index,} \)
\( I_{hya}, I_{yb}, \text{etc.} = \text{are the indices of various crops, and} \)
\( C_a, C_b, \text{etc.} = \text{represent the proportion of cropland devoted to different crops.} \)

Agricultural productivity regions also worked on the basis of Standard Nutrition Unit (SNU) technique which can be written in algebraic form as follows:

\[ \frac{1}{N} \left( \frac{\Sigma P(1) \times \text{Calo}(1)}{\Sigma A(1) \times 8,00,000} \right) \]

Where

\[ P(1) = \text{total production of the respective crops in the unit area,} \]
\[ PA(1) = \text{area under the crop in the unit} \]
\[ \text{Calo}(1) = \text{Caloric value of the crop concerned} \]
\[ N = \text{number of crops} \]

Correlation between the variables of agriculture and socio-economic development have been computed with the help of Karl Pearson's coefficient of correlation which may be expressed in equation form as:

\[ r = \frac{\Sigma xy}{\frac{\Sigma x \Sigma y}{N}} \]

\[ r = \frac{\sqrt{\Sigma x^2 - \frac{(\Sigma x)^2}{N}} \times \sqrt{\Sigma y^2 - \frac{(\Sigma y)^2}{N}}}{\sqrt{\Sigma x^2} \times \sqrt{\Sigma y^2}} \]
This measure is known as 'Product Moment Correlation Coefficient' or simply a 'Correlation Coefficient'. By symmetry it is clear that \( r_{xy} = r_{yx} = r \)

where,

\[
\begin{align*}
  r & \quad = \text{coefficient of correlation} \\
  x, y & \quad = \text{two given variables, and} \\
  r & \quad = \text{number of observations}
\end{align*}
\]

Properties of correlation coefficient (\( r \))

1. If the sign of \( r \) is positive the variables \( x \) and \( y \) will positively be related and if the sign is negative, they will negatively be correlated.

2. The value of \( r \) varies between \(-1\) and \(+1\). The value \(+1\) or \(-1\) indicates a 100 per cent positive or negative correlation. As the extent of correlation decreases the value of \( r \) approaches zero.

Significance Test of Correlation Coefficient or the students 't' distribution with (\( n-2 \)) degree of freedom may be written in equation form as follows:

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

where,

\[
\begin{align*}
  n & \quad = \text{the number of observations used} \\
  r & \quad = \text{the coefficient of correlation, and} \\
  t & \quad = \text{the calculated value}
\end{align*}
\]

In the last simple percentage and average methods are used to calculate the data collected through field survey with the help of a questionnaire. Levels of agricultural and socio-economic development have been computed by using Z-score technique which can be written as follows:

\[
Z = \frac{X_i - \bar{X}}{\text{S.D.}}
\]

Where,

\[
\begin{align*}
  Z & \quad = \text{score of variables} \\
  X_i & \quad = \text{original value of individual variable } x \text{ of ith component areal unit} \\
  \bar{X} & \quad = \text{Mean of individual variable of } x \\
  \text{S.D.} & \quad = \text{Standard deviation of variable}
\end{align*}
\]
Composite mean Z-score is calculated as follows:

\[ CS = \frac{\sum z_{ij}}{N} \]

Where,

- \( CS \) = Composite mean z-score
- \( \sum z_{ij} \) = Z-score of a variable j in observation i,
- \( N \) = Number of variables.