AGRICULTURAL GROWTH IN UTTAR PRADESH: A SPATIAL-TEMPORAL ANALYSIS

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Dedicated to MY TEACHER
DR. HARI OM VERMA

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CHAPTER-I

INTRODUCTION

The agricultural sector contributes significantly to the Indian economy in terms of income and employment. But it has been characterized by heavy population pressure, low levels of productivity and income, institutional rigidities and inadequate infrastructure. As in the case of other sectors of the economy, policy with regard to agriculture in India has been determined within the framework of the planning strategy adopted by the Government since 1951. Indian planners have accorded a high priority to agricultural development for several reasons. The Bengal famine in 1943, facing acute food shortages immediately in the wake of independence and humiliating search for food aid made the planners painfully conscious of the compelling need to provide minimum food security to the country. No wonder augmenting agricultural production with a view to achieving self sufficiency in food grains became one of the central objective of the of planning in India.

Indian agriculture stagnated during the first half of the twentieth century but it witnessed significant growth and transformation after 1951. Its growth rate accelerated from 0.37 per cent per annum during 1901-04 to 1941-44 to 2.68 per cent per annum during 1949-50 to 1996-97.[1]

The study of agricultural performance in the post independence period is often divided into the pre-Green Revolution (1949-50 to 1964-65) and post-Green Revolution (1967-68 to 1996-97) periods. In the pre green revolution the two main planks of agriculture policy were land reforms and large investment in irrigation infrastructure. As a result it took a visible acceleration in the growth rate of Indian agriculture. Thus, as compared to a growth rate of less than half per cent per annum in the pre-independence period, the growth rate of crops rose to 3.15 per cent per annum and that of food grains to 2.82 per cent per annum during 1949-50 to 1964-65. This growth was however characterized by a wide year to year fluctuation in output with severe food shortage during years of bad monsoon. In particular the early 1960s were

[1] Bhalla and Singh, 1997

characterized by substantial food grain deficits and large scale imports through PL480 had to be resorted to. Even these imports did help in ensuring better supplies of food grains. However, they also resulted in dampening food grain prices, thereby acting as a disincentive to domestic producer and more importantly, led to the erosion of self-confidence in the country.

All this changed with the introduction of new seed-fertiliser technology during the mid 1960s which was a major breakthrough that transformed rural India. During the early phase of the green revolution, from 1962-65 to 1970-73, the new High-Yield Variety (HYV) technology was more or less confined to Punjab, Haryana and some districts in western Uttar Pradesh (UP) in north- western India. Its introduction brought about some major changes in the nature and pattern of agricultural development in India. First, the wheat technology led to large increase in wheat yields and at a later period, in rice yields. Since the price regime was kept highly favourable for both these crops, there was a huge increase both in the area under cultivation and the output of these crops. This resulted in acceleration in the growth rates of output in the areas that adopted the new technology. Second, consequent to unprecedented increase in yields of rice, wheat and some other crops yield increase rather than area growth (the main source of growth during the pre-Green Revolution period) became the main source of agriculture growth. Given the gradual exhaustion of the possibilities of extending net sown area, this was a significant development and given the declining land-man ratio in Indian agriculture, it was important that yield increase should become the main source of growth. Third, the new technology was primarily based on irrigation.

The new economic reforms initiated in 1991 largely focused on fiscal adjustments, foreign trade and investment, industry and financial sectors. Some of the measures - notably reduction of subsidies, tariff reduction and trade liberalisation - do impact on agriculture. The reduction in fertiliser subsidies has raised the input costs for agriculture giving rise to apprehension that fertiliser use and consequently, agriculture production would be adversely affected. Tariff reduction and import liberalisation was expected to have reduced the cost and improved the availability imported materials and products entering agriculture

production. The relaxation in restrictions on import and export of farm products was expected to have a beneficial impact on agriculture.

Gulati (1997), estimated that on the average during 1987-88 to 1993-94, domestic prices of wheat, rice, cotton and sugarcane were well below prices prevailing in the world market; coarse cereal prices were roughly in line with and those of oilseeds much above world prices. Gulati further estimated that taking all crops together farmers were getting, in the early 1990's, some 16 percent to 25 percent (depending on basis of estimation) less than what they would have in the world market. This gives a measure of the potential increase in farm income arising from such a policy. If this could in fact be realised, there could have been a significant improvement in overall income distribution in favour of agriculture. This was the strongest argument in favour of liberalisation. That an improvement in terms of trade will stimulate faster agricultural growth is the other. Both claims are however, questionable.

Nayyar and Sen (1994) have shown that world market prices are liable to larger year-to-year fluctuations than domestic prices. Liberalisation might therefore mean that the Indian farmers have to face much more unstable prices. This happened in 3 to 4 out of ten years in the case of rice cotton and groundnut; and in six years in the case of wheat and maize meaning that when domestic production falls (rises) significantly, imports (exports) cannot always be used to moderate the rise (fall) in domestic prices.

Advocates of trade liberalisation tend to vastly exaggerate the impact of changes in agriculture prices on production. That the allocation of land between crops will significantly change in response to relative price changes is beyond dispute. However, the extent of such shifts is likely to be constrained by specifics of soil, climate and irrigation, which are not uniform across the country.

Despite the fact that Uttar Pradesh (UP) is the largest producer of food grains amongst the Indian States, the study of its agricultural productivity has not been accorded due significance. The economy of UP is characterised by the dominance of agricultural sector. Agriculture occupies a vital place in the economy of the state from various parameters such as contribution to Gross State Domestic

Product (GSDP) and providing employment to the people. Nearly, 73 percent of UP's population depends on agriculture for their livelihood. The net cultivated area in the state is 168.1 lakh hectares. In 2001-02, the state produced 254.98 lakh metric tonnes of wheat, 128.5 lakh metric tonnes of rice, 23.76 lakh metric tonnes of pulses, 7.25 lakh metric tonnes of oilseeds and 1179.82 lakh tonnes sugarcane. Total food grains production during 2001-02 was 441.35 lakh metric tones. Despite fifty years of planned development, UP continues to be one of the less developed states with a very high incidence of poverty. This is notwithstanding the fact that the state is endowed with vast natural and human resources.

UP is primarily an agrarian economy with substantial proportion (more than thirty percent) of state domestic product coming from agriculture. A large chunk of workforce is engaged in this sector. As agriculture is the main source of income generation, a bad crop year in the State (or in any district), poses a threat to the food security of the people.

The state divided into four agro climatic regions. Given the agro climatic conditions, the question which the planners face is: how to achieve an increased level of productivity. For this the existing cropping pattern, crop yield, agricultural productivity, input use available for agriculture and cropping intensity has to be analysed at the district level and policy recommendations should be made.

This study is an attempt to examine the determinants of agricultural productivity in UP. In examining the issue, district level agricultural productivity, its relation to district's factors of production like gross cropped area, area irrigated, number of agricultural workers, fertiliser consumption etc has been looked at. As the districts are different with respect to agro-climatic conditions, their copping pattern and variability over the years has been studied.

1.1 Objectives

1. To examine the agricultural growth pattern in pre and post liberalisation period.
2. To examine whether the regional disparity in agriculture has increased or declined in the State.

3. To analyse the trends and nature of cropping pattern at the regional level during the period from 1980-81 to 2001-02.

4. To examine which of the factors (proportion of area irrigated, fertiliser consumption per hectare, agricultural workers per hectare, rainfall etc.) have greater importance in explaining agricultural productivity in UP.

1.2 Hypotheses

The following hypotheses have been examined in the study :

1. Agricultural growth has declined in the post liberalisation periods in different regions of UP.
2. Regional disparity in agricultural production has declined in the last two decades.
3. Cropping pattern has not changed much in the 90's as compared to 80's.
4. Fertiliser use per hectare has greater importance in explaining agricultural productivity in UP.

1.3 Methodology

UP has broadly been divided into four major regions namely the western region, the eastern region, the central region and the southern region or Bundelkhand. Available data on area, production and yield of major crops have been examined to understand the trend in the production performance and relative contribution of area and yield to the growth of production. The analysis covers the period from 1980-81 to 2001-02. For different objectives different statistical tools have been used.

Spread of Crops across Districts

Coefficient of localisation is used to capture the spread of a particular crop across districts or regions. Higher value of coefficient of localisation for a crop implies that particular crop in concentrated in few districts.

Coefficient of localisation has been calculated by using the following formula:

CL_i = ½ [sum over j (L_{ij} /sum over j L_{ij}) – (sum over i L_{ij} / sum over j sum over i L_{ij})]

Where

CL_i = coefficient of localisation of i^{th} crop.

L_{ij} = area under I^{th} crop in I^{th} district

Crop diversification, in terms of percentage of gross cropped area under different crops have also been analysed in terms of Ginni coefficient and Entropy indices.

Gini co-efficient = $(\sum p_i^2)^{½}$

Pi =proportion of area under i^{th} crop.

Entropy index = $\sum p_i \log (1/p_i)$

Higher the value of gini coefficient, higher is the specialization in the state. The value of entropy index varies from 0 to $\log_e N$. Higher the value of entropy indices, higher will be the level of diversification.

1.4 Data Source

The major source of data for the analysis of the above-mentioned objectives is collected from Directorate of Agricultural Statistics, Ministry of Agriculture, Uttar Pradesh [various issues], and Statistical Abstract of Uttar Pradesh. [various issues], Handbook of Statistics, Uttar Pradesh [various issues] and Development Indicators of Uttar Pradesh, Economics and Statistical Department, State Planning Commission, Uttar Pradesh. The other major sources of data are Report of the Commission for Agricultural Cost and Pricing [various issues], Bulletin on Agricultural Prices. [various issues], Agricultural Statistics at a Glance [various issues]. For agricultural workers, the census data has been used.

1.5 Restructuring of Districts

The study covers the period from 1980-81 to 2001-02. Our analysis has taken into consideration the 48 old undivided districts as the unit of study because the study of the year starts from 1980-81 at which point of time the number of

districts in UP were 48. In 1980-81, there were 48 districts in UP. In 1984, two new districts namely Kanpur Sahar and Kanpur Dehat were created out of Kanpur (table1.1). Again in 1989 six new districts were formed. Hardwar was created from Saharanpur and Bijnor. Out of Mainpuri, Ferozabad was shaped. Sonbhadra came out of Mirzapur. Maharajganj was created out of Gorakhpur, while Siddharthnagar was created out of Basti. Mau came out of Azamgarh. In 1994, three new districts were shaped. Mahoba came out of Hamirpur while Bhadohi was created out of Varanasi. Padrauna was earlier part of Deoria. Again, in 1995 Ambedkarnagar was formed out of Faizabad. In 1996, Khushinagar was shaped out of Deoria. In 1997, thirteen new districts were created. Baghpat came out of Meerut. Out of Bulandshahar Gautambuddha Nagar was formed. Hathras was fashioned out of Mathura and Aligarh. Kannauj was created out of Farrukhabad. J.B.Phule Nagar came out of Moradabad. Auraiya came out of Etawah. Kaushambi was formed out of Allahabad. Chandauli and Sant Ravidasnagar were created out of Varanasi.

Table1.1
Restructuring of Districts

New District	Carved Out From	New District	Carved Out From
KANPUR CITY	KANPUR	G.BUDDHA NGR.	B.SHAHAR
KANPUR DEHAT	KANPUR	HATHARAS	MATHURA,ALIGARH
HARDWAR	SAHARANPUR	J.B.FULE NAGAR	MORADABAD
FIROZABAD	MAINPURI	KANNAUJ	FARRUKHABAD
SONBHADRA	MIRZPUR	AURAIYA	ETAWAH
MHARAJGANJ	GORAKHPUR	KAUSHAMBI	ALLAHABAD
SIDDHARTH NAGAR	BASTI	CHITRAKUT	BANDA
MAU	AZAMGARH	CHANDAULI	VARANASI
MAHOBA	HAMIRPUR	S. RAVI DAS NGR	VARANASI
AMBEDKAR NAGAR	FAIZABAD	BALRAMPUR	GONDA
KUSHI NAGAR	DEORIA	SHRAVASTI	BAHRAICH
BAGPAT	MEERUT		

Source: Census 2001

Chhitrakut was created out of Banda. Sant Kabirnagar was formed out of Basti and Siddharthnagar. Balrampur has been created out of Gonda and finally Shravasti was formed out of Bahraich. In this analysis area and production of new districts have been added to their original districts.

1.6 Plan of the Study

After introduction in Chapter I, Chapter II is devoted to the features of agricultural growth in UP – An Overview. Chapter III analyses the aggregate growth trends in UP. This is followed by a district level analysis of spatial patterns of growth of output in Chapter IV. An attempt is also made to examine the association if any, between the levels of productivity and use of various inputs at the district level. Chapter V gives a brief summary of the major findings and conclusion of the study.

CHAPTER-II

FEATURES OF AGRICULTURAL GROWTH IN UP: AN OVERVIEW

The most populous state of India is Uttar Pradesh. The economy of Uttar Pradesh is characterized by the dominance of the agricultural sector. Agriculture occupies a vital place in the economy of the state from various dimensions such as contribution to gross state domestic product and providing employment to the people. Nearly, 73 percent of its population depends mostly on agriculture for their livelihood.

According to the 2001 census, UP's population was a little over 166 million .This accounts to 16.4 percent of the country's population whereas the geographical area is only 7.5 percent of the total area. Hence, UP has a very high population density – 689 persons per square kilometer - which is double the national average, of 324. UP's population has increased almost three times since 1947. It is increasing at the rate of 2.3 percent per annum i.e. UP is now adding about 3.8 million people per year. Interestingly, if UP were to be a separate country, it would be the sixth most populous country in the world after China, India, United States, Indonesia and Brazil.

UP is a landlocked state with an agrarian economy. The industrialization pattern in the state is highly skewed with the western region of the state accounting for most of the industries of the state. The main agricultural crops in the state are wheat, rice, sugarcane, pulses and vegetables. The main industries in the state are cement, vegetable oils, textiles, cotton yarn, sugar, jute, and carpet. The sectoral break-up of the state's GSDP in 2002-03 was 32 percent from agriculture, 22 percent from industry, of which merely 11 percent came from manufacturing, and 41 percent from services.

This chapter attempts to identify and analyze the issues and problems associated with the agriculture sector of UP over the last four decades. The section I of this chapter looks at some of the economic and social aspects of the state and compares UP's performance relative to some of the other major states of India. The section II examines the growth of agricultural outputs in UP The section III deals

with intrastate variations in patterns of agricultural development within UP Section IV analyses the growth of agricultural inputs. Section -V brings together the summary and the main conclusion.

2.1 Economic and Social Indicators in UP

Between 1991 and 2001, UP's decadal population growth rate was 25.8 percent, above the national decadal average growth of 21.3 percent. UP is primarily rural, with an urbanization rate of about 21 percent in 2001. The net state domestic product of UP in 2001 was about 9 percent of India's total NDP. Per capita NSDP was 5770 rupees, roughly 40 percent below the average per capita NDP of 9508 rupees for the same year. In 1999-2000, 31 percent of UP residents lived below poverty line. This poverty ratio was the same for both rural and urban areas.

UP is among the most backward states in India, with high levels of poverty and low levels of social and economic development. Its rapidly expanding population makes it more difficult for development gains to be felt in the state.

Poverty levels have been decreasing in U.P. over the years. In 1973-74, about 57 percent of UP's population lived below poverty line and by 1983-84; this had decreased to 47 percent. As mentioned above, in 1999-00, this had decreased further, but was still at a high level of 31 percent. The decline in poverty levels coincided with, interalia, the increased agricultural production UP experienced during the Green Revolution, when HYVs were introduced in western UP and the following decades, when the new technology spread to the eastern part of the state.

Table2.1

Percentage of Population Below Poverty Line

STATE	1973-74			1983-84			1999-2000		
	Rural	Urban	Combined	Rural	Urban	Combined	Rural	Urban	Combined
Uttar Pradesh	56.53	60.09	57.07	46.5	49.82	47.07	31.2	30.89	31.15

Source : Planning Commission

In Punjab and Haryana, the two other states that experienced the Green Revolution of the 1960s, poverty levels have significantly decreased and in 1999-00, less than 10 percent of the population in either state lived below the poverty line.

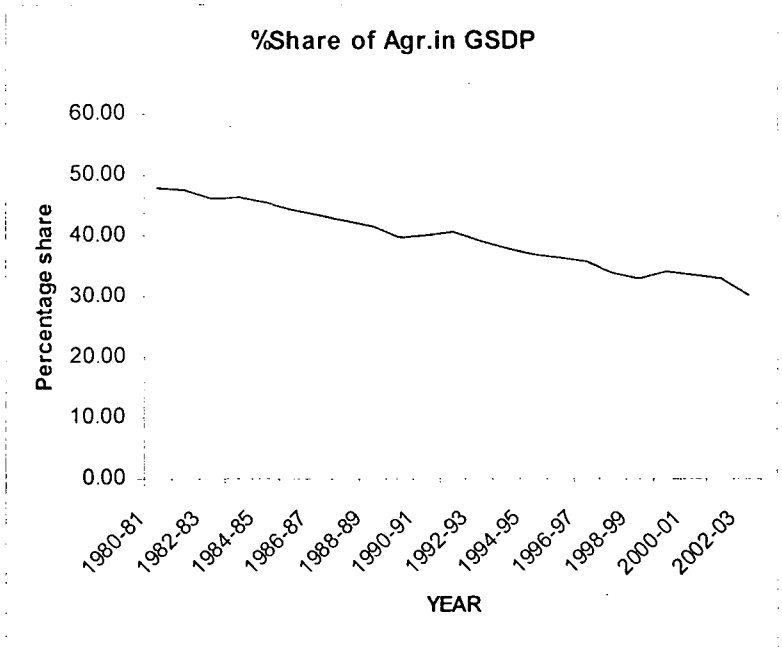
In 2002, 67 percent of total roads in UP were surfaced. This is a dramatic increase in the proportion of surfaced to unsurfaced roads since 1998, which was about 44 percent. At the same time though, the total road network in UP actually decreased by 11 percent between 1998 and 2002 and the increase in surfaced roads between those years were about 6 percent. Of the 15 major states, Haryana had the highest proportion of surfaced roads, 93 percent, but its road network is much smaller. Punjab, which is similar in size to Haryana, had a road network more than double Haryana's, of which 86 percent were surfaced (GOI, 2002).

Electricity consumption per capita in UP in 2002-03 was only 175.80 kWh; this was almost 80 percent less than the per capita consumption in Punjab of 837 kWh. (Indian Infrastructure, 2003).

2.2 Growth in Agricultural Output

There has been a marked structural transformation of the UP's economy in the nineties vis-à-vis that of eighties.

Fig 2.1



The intersectoral comparison of GSDP underwent a significant change. Agricultural sector whose share was almost half of GSDP in 1980-81 has come down to 39-19 percent in 1992-93 and 30.28 percent of GSDP in 2002-03 (fig 2.1).

From 1980-81 to 1991-92, the contribution of agricultural sector to GSDP varied between 50 percent to 40 percent since 1992-93, it has fallen sharply and now in the last 10 years it is well between 37 to 30 percent.

Srivastava (1999), has broadly divided Uttar Pradesh into five major regions, namely western region, the eastern region, the central region, the southern region or bundelkhand, and the hill region. With regard to the agrarian history, agro climatic condition and development experience, these regions are relatively homogeneous.

In the decades of sixties and seventies agricultural growth was biased in favour of western region. Singh (1987) has analysed the growth performance of UP agriculture both at regional and at district level for the period 1953 to 1979. During the entire period the growth rate of food grain output increased from 1.15 percent to 4.75 percent. In 70s share of hilly region and western region in UP agricultural production had increased due to the faster yield growth in these regions.

Srivastava (1999) has analysed the growth trends in the period 1967-70 to 1993-96.The food grain production grew at a rate of 1.95 percent in the decade of seventies. Hilly region experienced the highest growth rate of 2.69 percent followed by western region 2.26 percent. In 80s food grain production for UP as a whole grew at rate of 4.92 percent. Eastern region registered the highest growth rate followed by the central region and western region. In the period 1990-96 growth rate of food grain production for U.P as a whole declined to 2.65 percent. The highest growth was experienced by western region, fallowed by eastern region. In terms of food grain productivity growth, the performance of western region was the best during 60s and 70s but in 80s eastern region took the lead.

The performance of two major crops has shown different trends in 60s and 70s. Wheat had the highest growth of yield in the western region but production grew at a significantly higher rate in the eastern region. In case of rice, western region registered the highest growth both in yield and production in 1970s but in 80s eastern

region took the lead. Productivity growth was highest in the eastern region during the first few years of 90s but western and central region had the highest production growth (Srivastava, 1999).

Nirupam and Volavka (2005), has analysed acceleration in agricultural growth rates in India after Independence, from a rate of less than .8 percent per year in the first half of the 20th Century to 2.7 percent per year in the years 1949-50 to 1996-1997. This growth came as a result of investments in rural infrastructure overtime, such as irrigation, roads, power, agricultural research and development and extension services.

Fan, et al. (2000), found that government expenditure for rural poverty reduction and increased productivity growth was most effective when spent on rural infrastructure and agricultural research and development. Investment in education had the third-largest marginal impact on rural poverty and investment in irrigation and water and soil conservation were found to have impacts, though lesser ones, on rural poverty and growth. Using state-level data from 1970-73 to construct a simultaneous equation model, the authors argue that for every 100 billion rupees spent at constant (1993) prices on rural roads, R&D and education, the proportion of the rural poor declined by 0.65 percent, 0.45 percent and 0.22 percent, respectively.

Desai and Namboodiri (1997), found that non-price factors vis-à-vis price factors had a greater influence on growth in total factor productivity of agriculture. Government investment in agricultural R&D, education and extension services was the single most important determinant of technical change in agriculture. The authors constructed an estimated multivariate model to test for various determinants and their effects on total factor productivity between 1966-67 to 1989-90, such as the share of canal-irrigated land, rural literacy ratio, rural road density and the Gini coefficient of distribution of operational land. It is significant that investment in agricultural R&D is among the most effective instruments for reducing rural poverty. At present, the Indian government spends less than 0.35 percent of agricultural GDP on agricultural R&D. Roads in rural areas clearly play a tremendous role in poverty reduction, as they provide access not only to schools and health centers, but to markets where agricultural products are bought and sold. As

mentioned above, over 40 percent of UP's roads are unsurfaced, as opposed to ratios of less than 20 and 10 percent of unsurfaced to surfaced roads in Punjab and Haryana, respectively. Additionally, irrigation levels in Punjab and Haryana far surpass those in UP Given that the high yielding variety seeds grown in the Green Revolution states require more water than traditional seeds, it is possible that irrigation plays an even greater role there than India-wide(Fan, Hazell and Thorat, 2000). The role of soil conservation is gaining importance, as the loss of macro nutrients in soil has led to a slowing in yield growth, particularly in Punjab. The significance of the management and conservation of water in agriculture has also been studied (Pant, 2004; Chopra, 2003, Iyer, 2001)

The Green Revolution followed the introduction of high yielding varieties of wheat and rice in the late 1960s and early 1970s which began in Punjab, Haryana and Western Uttar Pradesh. This new technology of Green Revolution lifted India from the status of a food deficient country to a self sufficient one. Obviously, after a certain point, there is no way to increase land area under cultivation. The seed-fertiliser technology that came about via agricultural research and development made it possible to dramatically increase yields, making the use of existing land more efficient. Development gains for the rural poor came as a result of high yields and agricultural productivity in rural area.

The Green Revolution took hold in the Northwestern states for a variety of reasons. The areas of Punjab, Haryana and, to a lesser extent, western UP, which were rich in natural resources and possessed good physical and institutional infrastructure, were natural entry points for the high-yielding varieties of wheat seeds, whose introduction in India preceded those of rice. The spectacular growth in agricultural production in Punjab and Haryana during the Green Revolution is attributed to several natural and man-made factors. Among the natural factors, Roul, (2001) suggests the following: 1) nature's bounty in fertile alluvial soil of the Indo-Gangetic river systems of northern India; 2) geographical and geomorphological advantage of perennial Himalayan rivers amenable for multipurpose dams supplying cheap power and water to the canal systems; and 3) topographical advantage to lay canal systems and road networks at considerably lower costs as against those in

peninsular India. The man-made factors, on the other hand, included: 1) consolidation of landholdings; 2) assured irrigation; 3) rural electrification and of cheap power to agriculture; 4) agricultural research and extension network and 5) less exploitative agrarian structure.

Yields are low in Uttar Pradesh in almost all crops and districts when compare to Punjab and Haryana and this situation mainly obtains due to the disparity in the resource base, infrastructure and input application. The State is plagued with problems of water logging and saline sods and has an average land holding size of less than a third of Haryana and half of Punjab. Only about half of the total cropped area in the State is covered with irrigation compared to over 85 [per cent in Punjab. An average Punjab farmer applies over 120 kg of fertiliser per hectare compared to less than 50 kg by his counterpart in Uttar Pradesh. The odds, in fact, facing the Uttar Pradesh farmer is so many and so varied that the gap between the efficiency o the two is more likely to widen rather than decline in the near future (O Coutinho and T C Sharma, 1996).

Bhalla and Singh (2001), analyzed growth performance of Indian agriculture at the state and district levels over four decades for 43 crops. Bhalla and Singh also examined inter and intrastate comparisons over time, no matter which crops are produced where, assuming that prices of crops don't vary across districts. With this assumption, the differences in value productivity per hectare can be (a) either due to differences in the quantity of output of a crop produced per hectare (b) and/or due to differences in cropping pattern. Given this, the indicator can be seen as a measurement of income per unit of land. Districts and states that grow high-value crops but produce less in terms of quantity (kg/ha), can have higher yields when measured in rupees per hectare. For example, the average value of yield in 1992-95 was highest in Kerala, followed by Tamil Nadu. These states produce high-value cash crops.

Cropping patterns are largely determined by natural physical conditions, such as soil type, climate, rainfall patterns, elevation and topography (Bhalla and Singh, 2001). In each region, the combinations of crops grown are decided by relative prices and yield levels. New technologies, such as HYV seeds, can work

with relative price levels to change cropping patterns. Bhalla and Singh note that the roles of inputs, such as investment in irrigation infrastructure like tube wells, or the additional use of fertilisers and new seeds, make it possible to raise yield levels. This highlights the importance of modern inputs and their role in raising value productivity by raising physical yield and also by bringing about changes in cropping patterns. Between 1962-65 and 1970-73, the introduction of the new technology in the irrigated, wheat-producing northwest region of Punjab, Haryana and western UP had an intense impact on wheat production in this region and consequently, at the all-India level. In 1972-73, U.P.'s production of wheat made up 28 percent of the county's wheat output, while Punjab contributed 22 percent and Haryana 9 percent to India's wheat output. Combined, the three states provided 59 percent of India's wheat. At that time, very little progress had been made with HYV rice introduction and rice yields increased only slightly between 1962-65 and 1970-73.

The annual compound rates of yield growth, with the introduction of the new seed technology in Punjab, Haryana and UP during this period were higher than the national average, at 4.2 percent, 3.3 percent and 1.8 percent, respectively (table2.3). Similarly, the annual compound growth rate of output for India at that time was 2.1 percent, while in Punjab, Haryana and UP, output growth was recorded above the national average at 4.6 percent, 6.6 percent and 2.5 percent, respectively. While UP registered lower rates of growth in terms of yield and output than Haryana and Punjab in this period, this changes in later periods, as described below. Higher India-wide yield growth levels were seen between 1970-73 and 1980-83, as HYV wheat, along with the introduction of HYV IR8 rice, continued to spread in the northwest. Wheat and rice technology spread to hitherto lagging eastern UP during this period and advances in rice technology spread southward as well. The all-India compound growth rate of yield per annum in this decade was 1.8 percent, up from 1.64 percent in the previous time period and the annual compound growth rate of average value of output was 2.4 percent, up from 2.1 percent in the previous time period. (Bhalla and Singh, 2001).

In Punjab and Haryana, the annual compound growth rates of yield in the period of 1980-83 over 1970-73 declined to 2.6 percent and 2 percent, respectively, from 4.16 percent and 3.3 percent in the 1970-73 over 1962-65 period. Over the same period, this growth rate increased in UP from 1.8 percent per year to 2.4 percent per year. In terms of compound growth rate of output, UP's rate increased from 2.5 percent per year in the period of 1970-73 over 1962-65 to 2.77 percent per year in the period of 1980-83 over 1962-65. Concurrently, Punjab's growth rates in output declined to 4.7 percent per year from 6.6 percent and Haryana's growth rates in output declined from 4.65 percent to 3 percent per year. The increase in UP in terms of growth of yield and output was, as mentioned above, a result of spreading of new technology to the eastern part of the state (Bhalla and Singh, 2001).

The decline in the levels of yield and output in Haryana and Punjab does not continue in the next time period (1992-95 over 1980-83), but the initial levels of growth are not seen again in these two states, perhaps because soil potential, in terms of available nutrients, had reached its peak with the given technology. In Punjab, the compound growth rate of yield/ha increased less than a quarter of a percentage point in the 1992-95 over 1980-83 period from 2.6 percent per year to 2.8 percent per year, while the rate of output decreased from 4.7 percent to 3.9 percent per year. UP's yield growth during this time was 3.39 percent per year, up over a percentage point from 2.4 percent per year, and its rate of output grew at an average of 2.8 percent per year, up marginally from 2.7 per year. This growth was a sign of the new seed technologies further taking deeper root in the east, as output in eastern districts increased during this period. Between 1980-83 and 1992-95 in Haryana, the compound growth rate of yield/ha nearly doubled from 2.1 percent to 4 percent, while its growth rate of output also increased significantly from 3.02 percent to 4.7 percent.

The state of UP is about six times larger than Haryana and Punjab and has about four times the net sown area, or between 75 and 80 percent more net sown area than Punjab or Haryana.[21] In the benchmark triennium of 1962-65, UP's average value of output (Rs 93.6 billion) was about 82.5 percent higher than Haryana's (Rs 16.3 billion) and 76 percent higher than Punjab's (Rs 22 billion),

which roughly coincides with U.P.'s larger net sown area and shows that initially, UP may have had a slight advantage over Haryana in terms of average value of output (Table 2.2).

Table 2.2

Levels of Output and Growth in Punjab, Haryana and Uttar Pradesh during 1962-65, 1970-73, 1980-83 and 1992-95 : 43 Major Crops (at 1990-93 constant prices)

State	Average Value of Output (in Rs million)				compound growth rate*			
	1962-65	1970-73	1980-83	1992-95	A	B	C	D
Haryana	16,303.27	23,444.90	31,555.32	54,992.26	4.65	3.02	4.74	4.14
Punjab	22,078.87	36,897.73	58,654.10	92,549.04	6.63	4.74	3.87	4.89
Uttar Pradesh	93,627.51	114,460.68	150,372.86	210,249.47	2.54	2.77	2.83	2.73
All-India	565,642.79	666,706.24	843,474.10	1,260,430.47	2.08	2.38	3.4	2.71

A) 1970-73 over 1962-65

B) 1980-83 over 1970-73

C) 1992-95 over 1980-83

D) 1992-95 over 1962-65

Source: Bhalla and Singh, 2001

In Haryana, there was a change in cropping patterns which coincided with the increased growth rates. The percent share of food grains in gross cropped area decreased dramatically from 79.8 percent to 71.8 percent between 1980-83 and 1992-95, while the share in oilseeds in gross cropped area increased from 4.61 percent to 12.4 percent. This diversification to oilseeds most likely played a role in the significantly higher growth rates witnessed in Haryana. During this period in Punjab, there was a significant increase in the share of gross cropped area under rice, from 20.8 percent in 1980-83 to 31.2 percent in 1992-95. In UP, there were slight increases in percent shares of rice and wheat, from 20.3 percent to 22.3 percent in rice and from 31.1 percent to 36.5 percent in wheat. Contrary to Haryana, UP and Punjab both increased shares in production of food grains in the 1980-83 to 1992-95 periods. (Bhalla and Singh, 2001)

Table2.3

State-wise Levels of Growth of Crop Yield during 1962-65, 1970-73, 1980-83 and 1992-95, (at 1990-93 constant prices)

State	Average Value of Yield (in Rs million)				compound growth rate*			
	1962-65	1970-73	1980-83	1992-95	A	B	C	D
Haryana	3,927.21	5,091.01	6,229.13	10,128.73	3.30	2.04	4.13	3.21
Punjab	5,395.62	7,476.29	9,707.65	13,597.22	4.16	2.65	2.85	3.13
Uttar Pradesh	3,970.10	4,589.98	5,805.13	8,656.20	1.64	1.80	3.15	2.30
All-India	3,738.19	4,256.79	5,090.42	7,388.05	1.64	1.80	3.15	2.30

Note: * Average Yield = (Value output of 43 crop/area under 43 crops)

A) 1970-73 over 1962-65

B) 1980-83 over 1970-73

C) 1992-95 over 1980-83

D) 1992-95 over 1962-65

Source: Bhalla and Singh, 2001

The growth in output levels can be largely attributed to the use of HYV seeds and modern inputs such as fertiliser, rather than to an increase in area under crops. Between 1962-65 and 1992-95, the all-India annual compound growth rate in net sown area was less than half a percent. In Haryana, the compound growth rate in net sown area was 0.01 percent, in Punjab it was 0.26 percent and in UP, it was -0.01 percent. While growth rates in terms of yield and output continued to increase in the three time periods described above (1962-65 to 1970-73; 1970-73 to 1980-83; 1980-83 to1992-95) in U.P., (Table 2.2) they fluctuated in Punjab and Haryana within these periods. However, it is of great consequence to point out that growth

rates in output and yield over the entire 1962-65 to 1992-95 periods were higher in Punjab and Haryana than they were in U.P. During this period, annual compound growth rate in yield in Punjab was 3 percent; in Haryana it was 3 percent and in UP it was 2.6 percent. The annual compound growth rate in output during this period was 4.9 percent in Punjab, 4.1 percent in Haryana and only 2.7 percent in UP (Bhalla and Singh, 2001). Although Haryana's average compound growth rate of yield was higher than Punjab's, Punjab's yield has been traditionally higher than Haryana's. The state of UP is about six times larger than Haryana and Punjab and has about four times the net sown area.

Since 1972-73, UP has increased the land area under wheat production by roughly 37 percent, while Punjab and Haryana have increased land area under wheat production by 30 percent and 55 percent. Increases in yield have been about the same for all three states; UP's yield grew from 1229 kg/ha in 1972-73 to 2760 kg/ha in 2001-02, or by about 55 percent; Haryana's yield increased from 1757 kg/ha in 1972-73 to 4100 kg/ha in 2001-02, or by about 57 percent, and Punjab's yield increased from 2233 kg/ha in 1972-73 to 4503 kg/ha in 2001-02, or by about 51 percent.

Along with its status of top producer of wheat in India, UP is the second-largest producer of rice in the country between West Bengal and Punjab, which are the first and third largest producers. Similar to UP's low yield per hectare of wheat and other crops, the state makes up in area what it lacks in yield to become one of the country's top producers. In 2001-02, Uttar Pradesh produced 13.4 percent of the country's rice with a yield of 2120 kg/ha in an area of about 5.9 million hectares. At the same time, Punjab produced 9.5 percent of the country's rice with a yield of 3540 kg/ha in an area of 2.5 million hectares. Haryana was not one of the major producers of rice, as its output of made up less than three percent of the country's total production. However, Haryana's yield in kg/ha was 2650 kg/ha, or 20 percent higher than UP's yield. More strikingly, Punjab's yield was 40 percent higher than UP's.

As with wheat and other crops, rice yield (kg/ha) has been increasing over time. Between 1972-73 and 1984-85, rice yields (kg/ha) in UP increased by 44

percent, and between 1984-85 and 2001-02, rice yields increased by about 40 percent. Over the entire period, UP's rice yields increased by about 66 percent. In Punjab, rice yields increased by about 35 percent between 1972-73 and 1984-85 and between 1984-85 and 2001-02, they increased by 13 percent. Between 1972-73 and 2001-02, Punjab's rice yields increased by about 43 percent, compared to UP's 66 percent increase. In Haryana, rice yields grew by 35 percent between the early 1970s and mid 1980s and then by less than 8 percent between 1984-85 and 2001-02. Overall, between 1972-73 and 2000-01, Haryana's rice yield grew by 36 percent. It is noteworthy that although Punjab and Haryana's rice yields are still distinctly higher than UP's, their growth in yield slowed significantly between the mid 1980s and 2001-02 and this trend differs significantly from UP's pattern of growth. This could be due to a number of factors, among them, the declining soil fertility in Punjab and Haryana.

2.3 Intra State Variations in U.P.

Intrastate differences in UP have contributed to interstate differences between UP, Punjab and Haryana. UP has a land area of 240,928 sq. km. after the carving out of Uttaranchal and is comprised of 70 districts. Over two-thirds of the state falls in the Gangetic Plain region, which can be subdivided into the western, central and eastern areas, due to their differing histories and economic status (Sharma and Poleman, 1993). In 2001, over three quarters of districts were located in Eastern and Western UP Western UP and eastern UP's land areas are roughly the same, at 89,589 square km and 87,294 square km, respectively, and the regions have similar population sizes as well. Given this, it is not surprising that population density in the eastern and western regions are similar, at about 843 in the west and 867 in the east. Combined, the populations of east and west UP make up roughly three fourths of UP's total population of 166 million and eastern and western UP's combined land area accounts for about three quarters of the state's total land area.

Historically, eastern and western UP had different systems of landholdings, and although land reforms have been put in place, eastern UP still has a higher share of marginal land holdings. Under British rule, the Zamindari system of tenancy in eastern U.P. estranged cultivators from the land, as it further stratified

rural society into layers of tenants, subtenants and rentier landlords. In western UP, the bhaichara system allowed for peasant proprietorship, which gave tenants a greater incentive to invest in land and improve productivity, as is reflected by changes in cropping patterns, increases in yield and capital accumulation (Stokes, 1978). In 1960-61, marginal land holdings made up over 52 percent of land holdings in western UP in about 11 percent of operational agricultural area. At the same time in eastern UP, 62 percent of land holdings were marginal, and they were contained in about 19 percent of agricultural area. By 1980-81, the share of marginal holdings had increased in the west to 62 percent in about 20 percent of agricultural area, and in the east marginal holdings increased to 79 percent in 34 percent of agricultural area. In 1995-96, the proportion of marginal holdings UP-wide was about 75 percent and they operated in about one third of the state's operational agricultural area (CMIE, 2004).

Srivastava (1999) pointed out that in UP there had been an extreme inequality in the ownership of land and means of production at the time of independence. Entire agricultural land was owned by nearly two million proprietors. Inequality existed even among the small group of owners. Central and Eastern UP had the maximum inequality. In central UP, ten percent of Zamindars owned seventy five percent of land. Whereas in eastern U.P the same population owned sixty one percent of land.

Dreze and Gazdar, (1998) point out that in the eastern and central regions of UP, more so than in the western region, land is predominantly owned by high-ranking castes. Female participation in the labor force is lacking throughout the state and the class and caste system are resilient, even in relation to the rest of northern India. The gap between landowning castes and the dispossessed is sizeable throughout the state and this, combined with UP's patriarchal nature; continue the pattern of uneven development. The fertile Gangetic plain in UP is characterized by alluvial soil and is intensively cultivated. The perennial Ganga and Yamuna Rivers flow roughly parallel to each other through the state until they join in Allahabad, in the southeast. The plain is also watered by the major tributaries of the Ganga and Yamuna, namely the Ramganga, Gomti, Ghagra, Saryu and Gandale (Pant, 2003).

Rainfall varies throughout the state, from an annual 130 cm. in the north and north east plains to less than 70 cm. per year in the drier climes of the extreme southwest. Rainfall is generally abundant during the monsoon season between June and September, with about 80 percent of the yearly total occurring at that time (Sharma and Poleman, 1993). The average monsoon rainfall in 2002 was 891.3 mm in eastern UP and 765.7 in its western counterpart (Pant, 2003). The vagaries of monsoons, in addition to the need for year-round cultivation of crops, make irrigation a necessity for consistent, successful agricultural production. Although eastern and western UP is both part of the same Gangetic plain, the two regions are distinct from one another. Eastern UP is flood prone, less developed than the west, and experiences periodic occurrences of droughts. It has higher amounts of rainfall than its western counterpart, and in many areas lacks the capacity to cope with excess water via drainage systems. In 1999-00, less than 1 percent of kharif area was affected by floods in the west, while 8.5 percent was affected in the east. The frequent flooding in eastern UP can be largely attributed to deforestation in the upper catchment areas, leading to soil erosion and riverbed silting. Water logging in these areas during rainy season affects sowing and crop yields (Pant, 2003).

While the east receives higher levels of rainfall than the west, as described above, the western region has been able to rely on, to a much greater extent than in the east on irrigation in the form of canal networks and the development of its groundwater resources. Not only can flooding, which is seen more in the eastern region, damage and destroy crops , but this problem makes it more difficult for farmers to effectively use fertilisers, as floods can easily wash away an application of fertilisers, leaving a farmer and his land without the benefits of his investment of this input. This can lessen the incentive for farmers to invest in fertilisers. Additionally, fertilisers that are washed off the land can lead to contamination of rivers and water sources, creating a host of environmental problems. Fertiliser consumption has been traditionally higher in the west than in the east, and over time, the gap, which was quite narrow in 1965-66, has been widening. In 1965-66, fertiliser consumption per gross cropped hectare in the west was 6 kg/ha and in the east it was 4.2 kg/ha. The gap between the two regions

widened slowly from the mid-1960s to the mid-1980s with less than a 10 kg/ha difference in consumption in the two regions. By 1985-86, the west was consuming 94.6 kg/ha of fertiliser, while the east was consuming 82.9 kg/ha (Sharma and Poleman, 1993) and by 1998-99, fertiliser use had risen to 148.1 kg/ha in the west and 116.2 kg/ha in the east (Pant, 2004), a difference of almost 32 kg/ha.

In the past, public investment in canal irrigation was one of the greatest advantages of western UP over eastern UP In the 19th Century, the west received large amounts of public investment for irrigation, while the east received very little. Between 1830 and 1880, the eastern Yamuna, Lower Ganga and Agra canals were constructed in western UP, allowing for larger tracts of land to be irrigated than via the traditional wells, ponds and tanks. As human and animal labor was freed up from more labor-intensive forms of irrigation, such as the Persian wheel, cultivators were able to produce crops more efficiently and work the land more intensively by engaging in multiple cropping, which allowed more crops to be produced without necessarily increasing the area under production. This resulted in greater levels of economic activity in the west than in the east, which was visible in the forms of better-developed markets and roads (Sharma and Poleman, 1993).

At the time of independence, the land area watered by canal irrigation in the west was 12 times greater than in the east. The development of the Sharda Sahayak and Gandak irrigation projects improved canal irrigation in the east and the ratio of canal irrigated area between east and west decreased from 12:1 in the early 1950's to about 5:1 in the early 1960's. The ratio continued to decline in the mid 1970s, to 2.5:1 and by the mid-1980's, it was almost equal. However, by the time the east caught up to the west in this regard, the expansion of tube wells – seen as a necessity for the timely irrigation for the new HYVs—had taken off in the west (Sharma and Poleman, 1993) and canal irrigation was no longer the preferred mode of irrigation (Pant, 2004). The east again found itself behind the west in this form of irrigation. In 2001-02, the proportion of net irrigated area watered by canals was significantly higher in the east than in the west. Overtime the intensity of input use and hence, growth of output keeps changing for different regions, therefore, the spatial growth pattern of agricultural output is bound to change overtime.

In their estimated multivariate model of determinants of total factor productivity (TFP) in agriculture, (Desai and Namboodiri, 1997) were surprised to find that the share of canal irrigated area in total irrigated land was negatively correlated with TFP growth. The authors put forward that the explanation for this may be the inefficiency of canal irrigation management and expand this argument to include electricity generation at canal commands. These inefficiencies lead to the result that neither canal waters, nor electricity generated by them act as incentives for farmers to technologically enhance their agricultural practices.

At the beginning of the Green Revolution, the eastern and western region had roughly the same amount of irrigated area, but the difference between them was that over90 percent of land under irrigation in the east was watered from wells, ponds and tanks, while over 50 percent of land under irrigation in the west received water via canal irrigation (Sharma and Poleman, 1993). Over time, not only has the net irrigated area as a percentage of net cropped area grown to a greater extent in the west than in the east, but the growth in tube well irrigated area as a percentage of net cropped area has also been greater in the western region than in the eastern region. In 1964-65, the net irrigated area as a percentage of net cropped area was 38.7 percent in western UP and 36.3 percent in eastern UP (Sharma and Poleman, 1993). At this time, tube well irrigated area as a proportion of net cropped area in the west was almost double than in the east, at 7.8 percent and 3.9 percent, respectively. By 1975-76, the proportion of net cropped area under irrigation had increased significantly in the west, to 65.3 percent, while it rose to only 44 percent in the east. The proportion of net cropped area irrigated by tube wells was again almost double in the west than in the east, at 34 percent and 18.4 percent, respectively. By 1980-81, just under three fourths of net cropped area was irrigated in the west, while a little over half was irrigated in east. While tube well irrigated area rose from 34 percent to 42.7 percent in the west, it nearly doubled in the east, from 18.4 to 31.2 percent. Although the east had not expanded its irrigation overall to the extent of the west, the expansion was significant in the east in terms of growth of tube well irrigation. By 1998-99, net irrigated area as a proportion of net cropped

area was almost 90 percent in the western region, as opposed to about 61 percent in the eastern region.

Next to tube well irrigation, which waters about 71 percent of UP's net irrigated area, canal irrigation is the most prominent form of irrigation in the state, irrigating 21 percent of its net irrigated area in 2001-02. Canal irrigation was more prominent in the east than in the west, as 24.3 percent of area was irrigated by canals in the eastern region, versus 14.1 percent in the western region. The remainder of net irrigated area in U.P. is watered by other wells (5.8 percent), tanks and other means. The presence of other wells is more prevalent in the western region, where they water almost 6 percent of net irrigated area, than the eastern one, where they water less than 3 percent of net irrigated area. (State Government of U.P., 2004).

Sharma and Poleman,(1993) argue that although eastern UP had a late start in terms of irrigation and still lagged behind western UP Government intervention and private enterprise in exploiting water resources had led to a marked improvement in irrigation in eastern UP in the decade after the mid-1970s. Pant (2003) also discounts the general impression held by policy makers and researchers that the development of groundwater has been slow in eastern UP, and argues that its pace has actually been faster than in the west. However, this is true only if one looks at the tube well irrigated area as a proportion of net irrigated area, not net cropped area. While there is no denying that irrigation has continued to grow in the east and neither author disputes the fact there is a lag between the two regions, the area under irrigation in the west has continued to expand as well, and so has the gap between irrigation in the eastern and western regions of UP.

In 1998-99, the difference between east and west UP in terms of net irrigated area as a proportion of net cropped area was greater than it was in 1985-86. And the difference in 1985-86 was greater than it was in 1975-76. In the preceding decade, east and west had been almost equal in this regard. In terms of expansion of the proportion of area irrigated by tube wells, the story is a bit different, as this proportion was roughly double in the west than in the east in the early to mid-1960s, declined slightly in the 1970s, and then took a turn in eastern UP's favour beginning

in the early 1980's. In 1998-99, 80 percent of area in the west was irrigated by tube wells, as opposed to 60 percent in the east. However, one must bear in mind that in the same year, net irrigated area as a proportion of net cropped area was substantially higher in the west, at almost 90 percent, compared to 60 percent in the east. While tube wells have become more pronounced in the east over time, they are still irrigating significantly less area than those in the west.

The overwhelming majority of tube wells in both eastern and western UP are private. In the mid 1980s, the number of public tube wells in the east surpassed the number of such wells in the west, and this spurt in growth—from 0.77 state tube wells (per 1000 hectares of net sown area) in 1970-71 to 1.43 tube wells in 1980-81—may have played a significant role in the increase in tube wells in the east discussed above. However, public tube wells were plagued with mechanical problems and power shortages and as water discharge from these wells decreased and as the demand for assured and timely irrigation for the newly introduced HYVs increased; there was a surge in private tube well expansion (Sharma and Poleman, 1993). In 2001-02, the proportion of area irrigated in UP by state tube wells was a mere 3.5 percent, while private tube wells provided water to 67.9 percent of irrigated area. A higher proportion of public tube wells were found in the eastern region, as 5.6 percent of irrigated area there received water from state tube wells, while 2.4 percent of irrigated area in the west relied on state tube wells for irrigation. Private tube wells provided water to 77 percent of irrigated area in the west, and to 66 percent in the east.

The rapid expansion of tube well irrigation took its toll on the power sector in both the eastern and western regions. UP until the early 1980's, rural power supply exceeded demand, but as large-scale groundwater development was taken on by the private sector, demand for power outstripped supply. Power generation and transmission capacity became a constraint for the rate at which electric tube wells could be connected (Pant, 2004).

In the early 1960s, eastern UP experienced higher cropping intensities than its western counterpart. The percentage of irrigated area was roughly equal between the regions at this time and with higher levels of monsoon rains, the east

was capable of cultivating a larger kharif area, especially in the form of rice crops. With the expansion of tube well irrigation in the west following the introduction of hyvs wheat in the region, the east lost its natural lead. Cropping intensity grew in the west, while it stagnated in the eastern region until the late 1970s to early 1980s. Between 1975-76 and 1980-81, cropping intensity in eastern UP rose dramatically, from 134 to 145.2 (Sharma and Poleman, 1993). It was during this time that there was a significant increase in tube well irrigation in the east. It is also likely that this time period captures the effects of the spread of HYVs to the eastern region. In the western part of the state, the greatest increases in cropping intensities were witnessed between 1964-65 and 1970-71 (from 129.3 to 139.4) and, as in eastern U.P., between 1975-76 and 1980-81 (from 134 to 145.2). The combination of expansion of irrigation and other inputs, accompanied by the introduction of HYV wheat in the earlier period and its continued spread reflected by cropping pattern changes in the later period, may explain these significant increases. The spread of HYV rice in the later period was not reflected by cropping pattern changes, but there were significant increases in rice yield in both regions. By 1998-99, cropping intensity had crept up to 156 in the west and 150.8 in the east.

There was barely any growth in proportion of area under rice in eastern UP between the early 1960s and the mid-1980s. Meanwhile, the most dramatic change in the increase in percentage of gross cropped area under wheat in eastern UP came between 1975-76 and 1980-81 (22.2 percent to 31.7 percent); the change witnessed in this five-year cropping period was almost of same order of that seen in the 15-year cropping period between 1960-61 and 1975-76 (11.7 percent to 22.2 percent). HYVs of rice require more water than HYVs of wheat, so this may explain the lack of growth in area under rice in both the eastern and western regions of UP As mentioned earlier, Punjab and Haryana experienced shifts in cropping patterns towards wheat between the 1960s and 1970s, followed by shifts towards rice in the next decade.

Accompanying the increase in the percentage of gross cropped area under wheat in the east was a sharp decline in the proportion of gross cropped area under coarse cereals. The precipitous decline of coarse cereals began between 1970-

71 and 1975-76, slightly earlier than the rise of wheat. Between 1970-71 and 1985-86, the proportion of gross cropped area under coarse cereals declined from 29.6 percent to 10 percent. The area under pulses and oilseeds has also decreased in the east.

The most significant change in cropping patterns in the west was seen between 1964-65 and 1970-71, with the introduction of HYV wheat. Between these years, the proportion of gross cropped area under wheat increased from 21.6 percent to 31.6 percent. By 1985-86, this proportion had risen to 33 percent. Similar to the situation in the east, the area under rice cultivation increased slightly between 1964-65 and 1985-86, from 10.1 percent to 12.5 percent. As in the east, the share of pulses and coarse cereals declined, as rabi pulses and oilseeds compete with wheat (Sharma and Poleman, 1993). However, the declining trend in pulses in UP as whole seems to have slowed, if not slightly reversed. Between the 1980s and 1990s, the share of pulses in gross cropped area increased for the first time since the 1960s, from 11.43 percent to 11.92 percent. Although earlier cropping patterns in UP show a shift away from pulses and now show possible movement back towards them, UP has long been the largest producer of this crop in India and compared to the other top producers, Maharashtra and Andhra Pradesh, its yields in kg/ha are higher. In 2000-01, UP produced almost 21 percent of the country's pulses.

In terms of cash crops, UP is the top producer of sugarcane, contributing almost 40 percent, to India's overall sugarcane production in 2001-02, and the second-largest producer of vegetables, roots and tubers, contributing about 14 percent to India's overall production in 2000-01. The proportion of gross cropped area under sugarcane has changed little since the 1960s, as its presence has increased from 5.48 percent to 7.63 percent overall in UP Within the west, in 1960-61, the area under sugarcane was 10.4 percent of gross cropped area and this fluctuated slightly until 1985-86, when it was 10.3 percent. In the east, the area under sugarcane in 1960-61 was 4.4 percent and, after several fluctuations, the proportion of area under sugarcane in 1985-86 in the east was 3.3 percent (Sharma and Poleman, 1993).

UP is the top producer of wheat in India, but its yield in kg/ha is lower than that of Punjab and Haryana; the other top two producers of this crop. Within UP, western UP has had consistently higher yields in terms of kg/ha in wheat and both regions have improved over time. In 1964-65, prior to the introduction of HYV wheat, the crop was produced at 907 kg/ha in the west and 726 kg/ha in the east. Yields increased by about 30 percent in the west by 1970-71 to 1270 kg/ha, and similarly, by about 27 percent in the east, to 998 kg/ha. In the next five years, yields decreased marginally in the west and stagnated in the east. Between the periods of 1975-76 and 1980-81 wheat yield in western UP increased by 28 percent and between 1980-81 and 1985-86, yield again increased by 28 percent, to 2268 kg/ha. In the east, there was a 15 percent increase in yield between 1975-76 and 1980-81, followed by a 28 percent increase in yield between 1980-81 to 1985-86, bringing yield up to 1633 kg/ha and its pace of yield increase up to the west's level. Between 1985-86 and 1995-96, wheat yield increased by 23 percent in the east and by 22 percent in the west, showing that the east is still on par with, if not doing slightly better, than the west's rate of increase. In 2001-02, wheat yields were still substantially higher in the western region, at 3236 kg/ha, than in the eastern region, at 2377 kg/ha. This is not surprising, considering the benchmark yield levels, along with the east's slower growth between 1975-76 and 1980-81.

In 1995-96, the gross cropped area under wheat cultivation in western UP was 3.4 million hectares, of which 98.7 percent was irrigated. The total output of wheat in the region was 9.9 million tons. In the eastern region, gross cropped area under wheat was 2.9 million hectares, of which 91.9 percent was irrigated and production of wheat was 6.5 million tons or a third lower than in the west. In 2001-02, western UP marginally expanded gross cropped wheat area to 3.5 million hectares, while its eastern counterpart expanded its gross cropped wheat area to 3.4 million hectares, putting the two regions on almost equal footing in this respect. Irrigated area as a proportion of gross cropped area under wheat also improved in the east, to 95.7 percent, while it rose to 99.6 percent in the west. As mentioned above though, yields in the west were higher and therefore, it is not surprising that the west produced 11.4 million tons of wheat in 2001-02, while the east produced

8.2 million. While it is true that irrigation is slightly higher in the western region, it is likely that other factors are playing a role in higher yield and output levels of wheat in the west. Perhaps higher levels of inputs were put to use in the high income and high soil fertility areas of western UP, relative to the eastern region. In the case of rice, eastern and western UP started out with equal yield levels in 1964-65 — 635 kg/ha. While the east stagnated, the west's yield grew by 22 percent, to 816 kg/ha between 1964-65 and 1970-71. The east then picked up growth and had slightly higher levels of increase in the following 5 years and yield grew by 12.5 percent, while yield in the west grew by 10 percent. The east again stagnated, while the west's yield levels continued to increase by 17 percent, to 1089 kg/ha. Between 1980-81 and 1985-86, yields in the east took off again and grew by a whopping 43 percent, to 1270 kg/ha, while yields in the west grew by 33 percent, to 1633 kg/ha. Between 1985-86 and 1995-96, growth rate in yield levels slowed significantly in the east, to 23 percent, while growth rate in yield took a surprising negative turn in the west, to -5.5 percent. By 2001-02, rice yield was 2203 kg/ha in the west and 2125 kg/ha in the east. Rice yields in the east, after initially stagnating and falling behind western yields, have improved over time to the point where yields in the two regions are almost on par once again, as they were on the eve of the Green Revolution. Since the east cultivates rice on larger land areas than the west, its total output in tons is higher. In 1995-96, the west produced 2.9 million tons of rice in a gross cropped area of 1.2 hectares, while the east produced 4.6 millions tons in a gross cropped area of 2.8 million hectares (Government of Uttar Pradesh 2004).

Pulses thrived in both the eastern and western regions with relatively low levels of irrigation. UP is the top producer of pulses, contributing over 20 percent to India's overall production and among the top three producers, UP has the highest yield .In the eastern region in 1995-96, only 22.5 percent of 0.81 million hectares of gross cropped area under pulses was irrigated. Despite this, the region produced 0.62 million tons of pulses with a yield of 737 kg/ha (Government of Uttar Pradesh 2004). The western region had higher yield (860 kg/ha) and irrigation levels (62 percent of gross cropped area under pulses was irrigated), but cultivated pulses on about 44 percent of the area used in the eastern region and thus produced 0.38

million tons of pulses, or a third less than the eastern region. In 2001-02, yield levels increased to 869 kg/ha in the eastern region, surpassing yield levels in the west, which declined to 810 kg/ha. Due to increased yield levels, the east's total output of pulses increased slightly, to 0.64 million tons, despite a decrease in gross cropped area under pulses in the region. It is interesting that while the proportion of gross cropped area under irrigation declined, albeit marginally, from 22.5 percent to 20 percent, yield levels increased. The western region saw a decline not only in yield levels, but in area under cultivation of pulses, as well as irrigated area as a proportion of area under pulses. Therefore, it is not surprising that output declined in the west by almost 30 percent.

In 2001-02, UP was India's largest producer of sugarcane, contributing almost 40 percent of the nation's total output of the crop. Within UP, the western region is the dominant producer of sugarcane. In 1995-96, it produced over 80 million tons of sugarcane, while the eastern region produced less than 13 million tons. This is not unexpected, given that the western region cultivated sugarcane in an area almost five times the size of the area under sugarcane cultivation in the eastern region and that about 97 percent of this area in the west was irrigated, while less than 90 percent was irrigated in the east. Lower yield levels accompanied the lower proportion of irrigated area in the east; yield in the eastern region was about 49,000 kg/ha, while yield in the west was 66,000 kg/ha. In 2001-02, the western region increased its area under sugarcane cultivation marginally, by about 4 percent, as well an almost imperceptible increase in irrigation levels, but yield levels declined, nonetheless, to about 58,000 kg/ha and output declined marginally, to 77 million tons. In the eastern region, area under sugarcane increased by 32 percent, but the proportion of irrigated area declined to 72 percent, from 87 percent in 1995-96. Yield levels decreased very slightly, to about 48,500 kg/ha but because of the large increase in area under cultivation, output in the eastern region increased by 35 percent, to over 19 million tons. It is noteworthy that the decline in the proportion of gross cropped irrigated area in the east did not lead to the same level of decline in yield levels, indicating that in addition to irrigation, other inputs, such as fertiliser,

and natural features, such as soil, flooding, rainfall and climate probably play a large role in sugarcane production.

The adoption of HYVs in UP necessitated an expansion in irrigation and the additional use of other key inputs, such as fertiliser. As previously mentioned, upon examining cropping patterns in the state, major shifts were made with the spread of high yielding varieties of wheat in both the eastern and western regions, as the proportion of area under rice cultivation increased marginally in the west and declined in the east. This is not to say that HYV rice was not adopted in the state, but that wheat took a stronger hold, perhaps due to irrigation constraints. With its more evolved infrastructure, especially in regard to irrigation, western UP was quicker to adopt HYV technology and disaggregated output growth rates (rupees per hectare) reflect this.

Bhalla and Singh (2001) consider output growth rates in 55 UP districts between two time periods: 1962 -65 to 1980-83 and 1980-83 to 1990-93. Growth rates are divided into 3 categories: high (greater than 3.5 percent), medium (1.5 to 3.5 percent) and low (less than 1.5 percent). Within these categories, there are subcategories of value of output, which are divided into high output districts (over 8000 rupees/ha), medium output districts (5000-8000 rupees/ha) and low output districts (less than 5000 rupees/ha).48 Of the 18 western UP districts included in this analysis, 10 of them, or over 55 percent, had medium growth rates, while the remaining 8 experienced high growth rates. Over three quarters of the districts were in the low output category; over 20 percent were in the medium output category, and the remaining in the high-output category. Of the 14 eastern districts included in the analysis, all of them had medium growth rates and all districts were in the low-output category of less than 5000 rupees.

In the second time period, growth swelled in the eastern districts, as 11 of 14, or almost 80 percent of them graduated from the category of medium growth to high growth. In the west, the number of districts in this category remained at 55 percent, as three districts in the medium-growth category rose to achieve high growth, while three districts with high growth grates in the first period moved down into the medium-growth category in the second. In the east, where none of the

districts had an output of over Rs 5000 in the first period, 64 percent of them elevated output levels to between Rs 5000 and Rs 8000, and the remainder of the districts stayed at output levels of less than Rs. 5000. In the western region, the three quarters of districts which were in the low-output category in the first period, all graduated to the classes of medium and high-output.

Whereas only one district experienced high output levels in the first period, 7 districts, or almost 40 percent were in the high output-range in the second period and the remaining districts fell into the medium-output range.

Eastern UP's growth in the second period is significant, as it demonstrates that although the gap between eastern and western UP remains large, the east is making strides in the right direction. While the proportion of districts in the west with high output growth rates stagnated between the first and second time periods, there was a movement of 80 percent of eastern districts from the medium to high output growth rate class. The next step for the east is for districts to move into the high-output (over Rs 8000/ha) classes, as 40 percent of the western districts enjoyed this output level in the second time period, while none of the eastern districts did. Stagnation in the western region may be due to the loss of soil nutrients, after decades of intensive cultivation and fertiliser use. The increased planting of nutrient-rich legumes could help naturally replenish the soil with vital nutrients. In the east, large pockets of poor soil quality, as well as frequent flooding accompanied by poor irrigation infrastructure may be constraints to growth. A closer look at reasons for flooding, such as deforestation in catchment areas and poor drainage systems, as well as the harnessing of excess water for irrigation, would be essential in developing both a flood alleviation and irrigation expansion plan in the eastern region. In both regions, investments in research and development and extension services could have a tremendous impact on agricultural development and should be an integral part of an agricultural growth strategy for the state. The role of markets and access to them, in terms of basic infrastructure like roads and market information, should be analyzed. Landholding size and potential effects of consolidation needs further study as well.

2.4 Growth in Agricultural Inputs in UP

Punjab has traditionally had higher agricultural yield and output levels than Haryana, and UP and Haryana's outputs surpass those of UP Net sown area has changed very little in these three states and in India overall since the Green Revolution period, and increases in yield and output are therefore attributed to inputs and/or changing cropping patterns. In UP, Punjab and Haryana, varying output and yield can be seen as a reflection of different levels of inputs. Therefore, given that Punjab has higher levels of output and yield than Haryana, and Haryana has higher levels of yield and output than UP, it is not surprising that input levels and cropping intensity, a measure of the number of crops planted on a piece of land during the year, are highest in Punjab and lowest in UP. The effects of higher levels of agricultural inputs in India as a whole and within different regions in India have been studied. Bhalla and Singh (2001) employ a ridge regression analysis in an attempt to overcome the problem of the high degree of multicollinearity among the explanatory variables included in their analysis. In their ridge regression analysis of the northwest region over three periods (1970-73, 1980-83, 1990-93), as well as in the pooled period (1970-93) Bhalla and Singh found that the coefficients of all the included input and infrastructure variables were positive and statistically significant. In relation to their all-India analysis, the authors found that the northwest region showed higher production elasticities for fertilisers, tube wells, tractors, irrigation and regulated markets, suggesting that production in the region was more responsive to modern inputs and infrastructure. Assured and timely irrigation is one of the main requirements for the HYV seeds that sparked the Green Revolution (Sharma and Poleman, 1991; Pant, 2003).

In the pre-Green Revolution period (1962-65), the proportion of gross cropped area under irrigation was about twice as high in Punjab (58 percent) than in Haryana (31 percent) and UP (27 percent). By 1980-83, the proportion of gross cropped area under irrigation in Haryana had doubled to 62 percent and had increased significantly in UP to 47.5 percent and in Punjab to almost 87 percent. The narrowest increase between the 1980-83 and 1992-95 time period was witnessed by Punjab, as the proportion of gross cropped area rose less than 10

percentage points, to about 95 percent. But given the substantially higher level of gross cropped area under irrigation in Punjab than in Haryana and UP to begin with and the fact that only 5 percent of gross cropped area was not under irrigation in Punjab in 1992-95, the less dramatic increase seen there does not seem terribly significant. A small increase in the proportion of gross cropped area under irrigation was witnessed in Punjab over the better part of the 1990s, as it grew by .5 percent by the 1996-99 trienniums, to 95.5 percent. 28 In Haryana, between 1980-83 and 1992-95, the proportion of gross cropped irrigated area rose to 77 percent, a less dramatic increase than the initial doubling in the previous time period, but a significant increase nonetheless. As in Punjab, there was a slight increase in proportion of gross cropped irrigated area in Haryana over the 1990s, as it rose to 79 percent by 1996-99. Similar to the growth pattern in Haryana, the increase in UP's proportion of gross cropped irrigated area in the 1980-83 to 1992-95 time period was less than in the 1962-65 to 1980-83 time period, as it rose from 47.5 percent to 62 percent, still lagging behind Haryana, with which it had been on almost equal footing with in the 1962-65 period in this regard. However, by the end of the 1990s, the gap between Haryana and UP seemed to be narrowing, as its gross cropped irrigated area rose to almost 70 percent in 1996-99, while growth in gross cropped irrigated area in Haryana seemed to stagnate. Within UP, the development of irrigation infrastructure in the east has been slower than in the west, which exacerbates the large disparities seen between UP and Punjab in this respect, and to a lesser degree, Haryana. Canal irrigation had been developed in Punjab, Haryana and western U.P. prior to the Green Revolution and this irrigation infrastructure was a major factor in the introduction of HYVs in that region. Canal irrigation was an improvement over more traditional, labor-intensive forms of irrigation, like the Persian wheel. With the introduction of HYVs, irrigation via tube wells, which provide assured and timely irrigation for the seeds, experienced rapid growth.

In the pre-Green Revolution period (1962-65), the number of pump sets per 1000 hectares of net sown area in Punjab, Haryana and UP was roughly 8, 2 and 1.5, Respectively (Bhalla and Singh, 2001). Between 1962-65 and 1980-83, there was tremendous growth in pump sets in Punjab, as their number increased

from 8 to 158 (per 1000 hectares of net sown area), while the number of pump sets in Haryana and UP increased to 71.5 and 64, respectively.30 There was a slowdown in the addition of pump sets in Punjab between 1980-83 and 1987, as their number increased marginally, from 158 to 159. During the same time period, the highest increase in the number of pump sets was witnessed in Haryana as their numbers grew by about 45 percent, from 71.5 to 129. In UP, the number of pump sets increased by 67 percent, from 64 to 95. Between 1987 and 1992, Punjab again witnessed little growth in pump sets, as their numbers increased by about 5 percent, from 159 to 169, while in Haryana, the number of pump sets increased by about 11 percent, from 129 to 143.5. In UP during this time, the number of pump sets increased by about 28 percent, from 95 to 132. Punjab, Haryana and UP all employ both diesel-powered and electric-powered pump sets, at varying levels. In UP in 1986-87, diesel pump sets outnumbered electric pump sets by an order of about 4, while in Punjab, the number of diesel pump sets was double the number of electric ones. In Haryana, the ratio of diesel to electric pump sets was roughly equal. In 1991-92, Punjab's ratio of diesel to electric pump sets remained about the same, while in U.P., the ratio of diesel to electric pump sets increased from 4 to one to 5 to one. In Haryana in 1991-92, the ratio tilted in favor of electric pump sets, after being roughly equal in 1986-87. Reliance on diesel versus electric power, or vice-versa, can partly be seen as a reflection of availability and level of subsidization of diesel fuel and the availability of electricity, in terms of power grids, generation capacity and level of subsidization..

Punjab had higher consumption of fertilisers than in Haryana and UP in the early to mid-1960s, at almost 8 kg per hectare, or about twice the consumption in UP At that time, UP's consumption of fertilisers was about 1 and a half times greater than consumption in Haryana (CMIE Agriculture, 2004). Between 1962-65 and 1980-83, fertiliser consumption increased by about 91 percent in Haryana, to almost 69 kg per hectare and by about 95 percent in UP, to just over 75 kg per hectare. At the same time, Punjab's fertiliser consumption increased by about 96 percent, to 192 kg per hectare. Between 1980-83 and 1992-95, Haryana's fertiliser consumption grew by 64 percent, while UP's increase in consumption was 44

percent and Punjab's was 35 percent. Even with this slowing of growth in fertiliser consumption in Punjab, the state still had the highest level of fertiliser use, at almost 297 kg per hectare, due to its higher benchmark level and its increase in the previous time period. However, between 1980-83 and 1992-95, Haryana, where fertiliser consumption had previously been lower than UP, surged ahead of UP, with 191 kg per hectare as opposed to UP's 134 kg per hectare. In the mid to late 1980s, there was a distinct change in cropping pattern in Haryana, which may have necessitated the increased use of fertilisers. There was a breakthrough in HYV oilseed technology in the mid 1980's and between 1980 and 1990, Haryana increased the percent share of oilseeds almost three-fold, from 4.6 percent to 12.4 percent, while the percent share of coarse cereals decreased from about 25.5 percent to 14.2 percent.

Punjab has the highest use of tractors among the three states since 1962-65. In that triennium, there were 2.4 tractors (per 1000 hectares of net sown area), while in Haryana and U.P.; there were .7 tractors and .5 tractors respectively. By 1980-83, there were 25 tractors (per 1000 hectares of net sown area) in Punjab and 17 tractors (per 1000 hectares of net sown area) in Haryana. UP witnessed the smallest increase as the number of tractors there rose to only 8.25 (per 1000 hectares of net sown area), and thus fell behind Haryana, with which it was almost on par with in the mid 1960's. Between 1980-83 and 1999-00, disparities between Punjab and Haryana decreased, while they continued to increase between UP and Haryana and Punjab. In 1999-2000, the number of tractors (per 1000 hectares of net sown area) was 102 in Punjab, 93 in Haryana and 39.5 in UP.

Between the 1980s and 1990s, area under rice cultivation continued to increase in Punjab, from about 21 percent of gross cropped area to 31 percent, while the proportion of area under wheat increased very little, to just below 49 percent. Pulses and coarse cereals continued their decline. In Haryana, a major shift was seen as the state moved towards oilseeds, as their proportion of gross cropped area increased from about 5 percent to 12 percent, following a breakthrough in HYV technology. Increases in the proportion of gross cropped area under wheat and rice were also registered, as wheat rose from about 31 percent to 36 percent and rice rose

from about 10 percent to 16 percent. Meanwhile, area under coarse cereals and pulses declined. In UP, very little change was seen in cropping patterns. Area under rice increased slightly, from about 20 percent to 22 percent, and area under wheat increased from about 31 percent to over 36.5 percent. Coarse cereals continued to decline, albeit more slowly than in between the 1970s and 1980s, while oilseeds dropped substantially, from about 14 percent of gross cropped area to about 7 percent. The decline in area under pulses stopped and even reversed slightly, as it increased from 11.43 percent to 11.92 percent. Essentially, the shifts in cropping patterns have not been as dramatic in UP as they have in Punjab and Haryana, especially in regard to rice. Even so, UP is the second-largest producer of rice in India, behind West Bengal.

With Levels of agricultural inputs, such as irrigation, fertiliser consumption, mechanization vis-a-vis tractors, have been consistently higher in Punjab than in Haryana and UP With breakthroughs in HYV technologies, increasing cropping intensities were witnessed, and more strongly so in states with greater shifts in cropping patterns reflecting adoption of the new seeds. The above-mentioned inputs, as well as soil and climate conditions, are all likely to have impacted the level of adoption and the ease with which the new technology was absorbed.

2.5 Conclusion

Bhalla and Singh (2001) and several other authors undertook empirical analysis along with descriptive statistics bear testimony to the fact that technical variables such as use of fertilisers, irrigation and high yielding verities seeds or environmental variables such as rainfall, soil fertility and economic variables such as size of land holding, size of the markets, availability of power for agricultural use are all significant variables for the determination of agricultural performance. The use of inputs for modern agriculture explained the extent of variation in agricultural output. However, if one were to single out the most significant variable, from the one listed above to explain the differential agricultural performance of UP relative to Punjab and Haryana is irrigation. Almost a quarter of the total net sown area of

UP is without irrigation. Parts of rural infrastructure, such as availability of reliable power supply, and roads to the regional markets are other variables that seem to make a difference.

The level of public investment in agricultural sector had an impact on agricultural performance over a period of time. Successive governments in the states of Punjab and Haryana since the pre green revolution days had invested heavily in the rural infrastructure-roads, power, and irrigation networks and especially in the case of Punjab in agricultural R&D in the early green revolution period (Roul, 2001).

The western region of UP during the initial green revolution period could make good use of HYV seeds as this region was in better shape as far as irrigation, and to a lesser extent as far as roads and power availability were concerned.

With the passage of time the gap of eastern UP with western counterpart narrowed. It has significantly stepped up irrigation infrastructure and improved crop yields, both in terms of value and physical yield. The growth of agricultural output in the east as Bhalla and Singh demonstrate in their analysis, the overwhelming majority of eastern districts has experienced high output growth rates.

A crop rice which was naturally suited to the eastern region rainfall and flood patterns, yield levels, which initially stagnated during the early green revolution period, have grown substantially. This growth, accompanied by a recent stagnation in levels of rice yields in the west, has helped to narrow the gap between the two regions, as far as rice is concerned. Given the eastern region's natural tendency toward rice, it is surprising that there has not been a significant shift in cropping patterns towards rice, even after the introduction of HYV rice seeds. The improvements in the eastern region are encouraging, disparities between the two regions still persists. Levels of irrigation are higher in the west .within the larger irrigation picture, level of tube well irrigation -necessary for the assured and timely watering of HYVs are higher in the western region as well. at the same time,

the eastern region suffers from floods and water logging, necessitating a strategy for alleviation of these problems, as well as for the conjunctive use of land and surface water. The western region also continues to have more developed infrastructure, in terms of road and electricity.

The wide interstate disparities that have persisted between and its green revolution neighbours was because of regional differences within UP Punjab and Haryana continue to enjoy significantly higher levels of agricultural growth in the value of output and in value of physical yields (kg\hectare) have been consistently higher in Punjab and Haryana since the initial green revolution period as well. Punjab and Haryana's irrigation infrastructure is still more developed than UP's and irrigation levels have continued to be remarkably higher in the two states. Similar to the problem of lower bench mark levels in the eastern region of UP relative to its western counterpart, the effects of lower initial levels of both inputs and outputs in UP, relative to Punjab and Haryana.

Punjab and Haryana's success come from their willingness and capacity to adopt new varieties of seeds and not only from their natural features, such as fertile soils and higher levels of inputs, such as irrigation and fertilisers. This diversification is seen in the change of cropping patterns in the states, both of which have been more pronounced than the changes in UP It is possible that in UP, where landholding size is predominantly marginal, farmers are more risk –averse and hesitant to diversify. One year of crop failure could wipe a small farmer out of business and thus, instead of trying something new, farmers play it safe by relying heavily on wheat and rice production that benefit from the assured procurement of these food grains by the food cooperation of India.

CHAPTER-III

AGGREGATE GROWTH TRENDS IN UTTAR PRADESH

The main purpose of this chapter is to undertake an analysis of the regional patterns of levels and growth of agricultural output during the period 1980-81 to 2001-02. The main sources of output growth being yield increases, area increases and cropping pattern changes, an attempt has been made to study the contribution made by these components to agricultural growth in various regions. Finally, an attempt has also been made to analyse the relationship between the growth of male agricultural workers and the growth of output over time.

Crop wise data on area and output of 24 major crops for 48 districts have been obtained from Directorate of Agricultural Statistics, Ministry of Agriculture, Uttar Pradesh.

The entire period has been divided into two broad phases namely, the pre liberalisation period and the post liberalisation period. The value of the crop output has been obtained by using all India prices for the triennium ending 1993[2]. Growth rates are trend growth rates[3]. Uttar Pradesh has been broadly divided into four major regions namely the western region, the eastern region, the central region and the southern region or the Bundelkhand region.

The organization of the chapter is as follows. After the introduction in part I, part II is devoted to a brief review of levels and trend growth of agricultural output at the regional level. This is followed in part III and Part IV by a discussion of the regional pattern of level and growth of yield and of gross cropped area respectively. Part V is devoted to a brief discussion of association between yield levels and growth with the level of use of inputs[4] like irrigation, fertiliser, agricultural workers, rainfall etc. Part VI is devoted to the trend growth rate of area, production and yield of individual crops. Changes in the cropping pattern over the period of the study are discussed in part VII. Part VIII then deals with the regional pattern of changes in the

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2 Constant price has been taken through out the analysis though taking constant prices restricts the analysis of effects of price changes

3 Significant at 1 percent level

4 Data for HYV seeds is not available, so it has not been incorporated into my analysis.

agricultural worker productivity. Finally, part IX brings together the summary and the main conclusions of the region wise analysis.

3.1 Trend Growth Rate of Crop Output

Table 3.1 which gives levels and trend growth rate of aggregate crop output at the regional level during the period 1980-81 to 2001-02, brings out several interesting features of the regional pattern of agricultural development in Uttar Pradesh. For the purpose of analysis, the 1980-81 to 2001-02 has been divided into two sub-periods, namely 1980-81 to 1991-92 (first period) and 1992-93 to 2001-02 (second period)

Table 3.1
Region wise Levels and Trend Growth of Agricultural Output During 1980-81 to2001-02
(At 1990-93 constant prices)

Sl no	Region	Value of Output(in Rs.Lakhs)				Trend Growth Rate*		
		1980-81	1991-92	2001-02		A	B	C
1	BUNDELKHAND	70522.53	70615.80	110002.44		-0.11	2.84	1.29
2	CENTRAL	205331.81	310533.53	412275.40		3.83	2.75	3.02
3	EASTERN	381149.30	603274.57	743040.92		4.21	2.63	3.01
4	WESTERN	628527.05	919232.53	1120029.35		3.43	2.15	2.84
	UTTARPRADESH	1335244.90	1970655.26	2385348.11		3.49	3.49	2.75

* Percent Trend Growth Rate
(A)1980-81 to 1991-92
(B)1991-92 to 2001-02
(C)1980-81 to 2001-02

Source: Department of Agricultural Statistics, Uttar Pradesh

Taking the entire period 1980-81 to 2001-02, total agricultural output in Uttar Pradesh at 1990-93 prices increased at an annual rate of 2.75 percent. During this period, the highest output growth rate[5] of 3.02 per cent was recorded by the central region of UP, followed by the eastern region and the western region. The lowest trend growth rate of 1.29 percent was registered by the Bundelkhand region.

The period of 1980s is characterised by the extension of new seed fertiliser technology from wheat to rice and its spread to the eastern and the central UP. In the

[5] Trend Growth Rate has been taken in the entire analysis

matter of growth of agricultural output, the period 1980-81 to 1991-92 marks a turning point in UP's agricultural development. An interesting feature of the 80s was that agricultural growth permeated to other regions like the eastern and the central region in UP. The period 1980-81 to 1991-92 showed a slight slow down of growth in western region but a significant increase in the growth rate in the eastern and central region. The most significant development was a notable high growth in the eastern region where the trend growth rate increased to an unprecedented level of 4.21 percent per annum. The central region also recorded a significantly higher growth rate as compared to the western region. However, there was negative growth in the Bundelkhand region.

The significantly high growth rate in the eastern and central regions of UP was a development of major significance. This is because of the fact that rapid growth in their agriculture is likely to percolate to the large population dependent on agriculture and thereby making a significant dent on rural poverty.

Inter temporal comparisons shows that in the post liberalisation period, the trend growth rate of crop output of UP as a whole declined from 3.49 percent during 1980-81 to 1991-92 to 2.06 percent in 1992-93 to 2001-02. Except the Bundelkhand region, the trend growth rate declined for all the regions. The most significant development was that the relative position of the regions with regard to their growth rates underwent a significant change. The Bundelkhand region recorded the highest growth rate of 2.84 percent followed by the central, the eastern and the western region. Western region, which achieved the highest growth rate immediately after green revolution, recorded the lowest growth rate in the 90s. Saturation was reached in the western region with respect to the input use, so that the productivity was increasing slowly. At the same time, the eastern and the central region had a faster growth in agricultural production due to better and enhanced utilisation of new technology.

In 80s, the eastern region registered the highest growth rate followed by the central region and the western region. But in the 90s, the highest growth was experienced by the Bundelkhand region followed by the central and the eastern

region. The study highlights that Bundelkhand region has done reasonably well in the post liberalisation period vis-à-vis other regions. It might be because Bundelkhand was the most backward region during the 80s. Though its output growth has increased in the 90s, the productivity level in the Bundelkhand region remained lower vis a vis other regions of UP. In absolute terms, western region's contribution to the incremental output was the highest in both the periods.

The main components of growth of output are growth of yield, growth of area and changes in cropping pattern. The following sections are devoted to a discussion of the contribution made to growth of output during 1980-81 to 2001-02 by yield growth, area growth and cropping pattern changes at the regional level.

3.2 Changes in Crop Yields

This section deals with the regional level changes in the growth of land yield in UP during 1980-81 to 2001-02. Land yield has been defined as the value of output of 24 crops included in the study divided by the cropped area under these crops.

With yield raising new technology gradually spreading to more areas, yield rather then area growth has become the predominant source of growth in UP agriculture since mid sixties. Table 3.2 gives the nature of changes that have taken place in the levels and growth of crop yield during 1980-81 to 2001-02. It brings out that the value of output for UP as a whole grew by 2.75 percent, whereas land yield for the state registered the trend growth of about 2.05 percent per annum, accounting for as much as 80 percent of the growth output during this period. Increase in yield was recorded by the all the four regions of UP, the highest increase having been registered by the eastern region followed by central, western and southern regions, in that order.

Because of the development of irrigation, yield level was quite high in the western region. On the other hand, it was quite low in the rain fed Bundelkhand region. For UP as whole, yield increased at a rate of 2.68 percent per annum during

Table 3.2

Region wise Levels and Trend Growth of Agricultural Yield During 1980-81to2001-02

At 1990-93 constant prices

sl no	Region	Value of Output per hectare (in Rs.)			Trend Growth Rate*		
		1980-81	1991-92	2001-02	A	B	C
1	BUNDELKHAND	4166.28	3800.30	4728.13	-0.25	1.46	0.79
2	CENTRAL	6115.47	8110.17	9611.60	2.75	1.10	2.10
3	EASTERN	5759.01	7780.04	8722.81	3.04	1.22	2.17
4	WESTERN	8930.91	11521.90	13117.81	2.68	0.42	2.02
	UTTAR PRADESH	6754.02	8839.25	10074.91	2.68	0.94	2.05

* Percent Trend Growth Rate
(A)1980-81 to 1991-92
(B)1991-92 to 2001-02
(C)1980-81 to 2001-02

Source: Department of Agricultural Statistics, Uttar Pradesh

1980-81 to 1991-92. Highest trend growth of yield was recorded by the eastern region. The eastern region was followed by the central region and the western region. The trend growth rate of the productivity level was negative in the Bundelkhand region.

Inter temporal comparison shows that the trend growth rate of yield has declined in the post liberalisation period. The only exception is the Bundelkhand region where the yield growth rate has increased. For UP as a whole, trend growth rate of yield declined from 2.68 percent in the pre liberalisation to 0.94% in the post liberalisation period. The performance of the western region was quite dismal with respect to growth in output per hectare.

3.3 Levels and Growth of Gross Cropped Area

Another source of agricultural output is the growth of cropped area. This section deals with the region wise pattern of growth of cropped area during the period 1980-81 to 2001-02.

For UP as a whole, , gross cropped area (area under 24 crops) recorded trend growth of 0.23 percent, contributing only nine percent to total growth of output

during the period 1980-81 to 2001-02 (Table 3.3). During 1980-81 to 2001-02, cropped area for UP as whole recorded a growth of 0.2 percent. The trend growth was high in the eastern region where the new technology was extensively adopted during this period. More and more area in the eastern region came under rice cultivation. The western region recorded zero growth rate of cropped area in the pre liberalisation period.[6]

Table 3.3

Region wise Levels and Trend Growth of Area During 1980-81 to2001-02

sl no	Region	Area(in Hectare)			Trend Growth Rate*		
		1980-81	1991-92	2001-02	A	B	C
1	BUNDELKHAND	2023170.50	2065793.00	2326552.00	0.12	1.17	0.67
2	CENTRAL	3886741.50	3993691.00	4289353.00	0.10	0.49	0.42
3	EASTERN	7816254.50	8209923.00	8518363.00	0.50	0.66	0.29
4	WESTERN	8113887.50	8117326.00	8538233.00	0.00	0.18	0.31
	UTTAR PRADESH	22962409.00	23397949.00	23676112.00	0.20	0.06	0.23

* Percent Trend Growth Rate
(A) 1980-81 to 1991-92
(B) 1991-92 to 2001-02
(C) 1980-81 to 2001-02
Source: Department of Agricultural Statistics, Uttar Pradesh

During the period 1991-92 to 2001-02, there was an increase in the trend growth rate of cropped area for all the regions. Maximum increase was recorded in the Bundelkhand region.

The inter-temporal comparison shows that the trend growth rate of gross cropped area for UP as a whole has declined in the post liberalisation period. Nevertheless, for the period 1991-92 to 2001-02, co-efficient of determination (R^2) is estimated to be 0.018.

[6] However, during the period 1980-81 to 91-92, the regression results of area in Bundelkhand, central and western regions, and UP as a whole do not show any secular trend.

3.4 Input Use, Yield Levels and Growth of Output

Table 3.4 gives region wise information on the area under irrigation and quantum of fertiliser used. It clearly comes out from the table that the levels and growth of crop output, at both the regional and state levels, are positively associated with the use of these two inputs. During 2001-02, high productivity regions were the western, the eastern and the central regions, in that order. All these regions were characterised by high levels of area under irrigation. The eastern region had comparatively less area under irrigation. But this region receives very high rainfall which compensates for the lack of irrigation potential. From table3.4B, it is obvious that eastern region receives comparatively higher rainfall vis-a-vis other regions during kharif season.

Similarly, all these regions used more than 110 kg of fertilisers per hectare. In the western region, fertiliser use was as high as 154 kg per hectare. During the period 1981 to 2001, the number of agricultural workers increased by almost 50 percent for all the regions (table3.4A). Since productivity and number of workers per 1000 hectare have increased for all the regions during the period 1980-81 to 2001-02, it can be inferred that there is a positive association between productivity and number of workers per 1000 hectare. In other words, one can say that productivity in all the regions has been affected by number of workers.

Table 3.4

Region wise Level of Input used During 1980-81,1991-92 and 2001-02

Sl no	Region	Consumption of fertilisers (Kgs./Hect)				% of GCA Irrigated		
		1981	1991	2001		1981	1991	2001
1	BUNDELKHAND	24.95	47.96	71.60		23.23	35.73	42.66
2	CENTRAL	49.06	83.78	119.68		44.41	63.73	74.30
3	EASTERN	55.16	91.37	126.39		42.24	55.52	64.61
4	WESTERN	65.81	107.45	154.70		63.13	81.02	85.49
	UTTAR PRADESH	52.21	87.76	126.00		47.42	62.45	70.77

Source: Department of Agricultural Statistics, Uttar Pradesh

Table 3.4A

Agricultural Workers per1000 hectare

	1981	1991	2001
BUNDELKHAND	673	872	1045
CENTRAL	1069	1256	1546
EASTERN	1015	1228	1890
WESTERN	863	1079	1243
UTTAR PRADESH	905	1109	1511

Source: Department of Agricultural Statistics, Uttar Pradesh

Table3.4B

Rainfall in Kharif Season

kharif		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
Rainfall	1980-81	1401.6	1530.3	1435.0	790.0	1289.2
Rainfall	1981-82	688.8	915.3	1105.9	644.9	838.7
Rainfall	1982-83	1040.3	905.4	909.0	711.2	891.5
Rainfall	1983-84	910.8	842.6	899.5	970.6	905.9
Rainfall	1984-85	700.8	681.4	1085.0	670.8	784.5
Rainfall	1985-86	825.7	958.0	940.4	782.1	876.5
Rainfall	1986-87	594.1	745.6	814.5	568.7	680.7
Rainfall	1987-88	569.4	372.6	842.0	311.1	523.8
Rainfall	1988-89	726.9	951.7	975.9	973.1	906.9
Rainfall	1989-90	552.0	665.7	964.8	581.3	690.9
Rainfall	1990-91	898.3	751.0	1043.6	781.0	868.5
Rainfall	1991-92	763.2	644.2	904.1	586.8	724.6
Rainfall	1992-93	760.8	529.7	718.2	589.6	649.5
Rainfall	1993-94	746.2	567.8	809.6	688.2	702.9
Rainfall	1994-95	789.7	668.5	911.7	746.5	779.1
Rainfall	1995-96	816.8	638.5	806.0	776.6	759.5
Rainfall	1996-97	779.3	740.0	832.4	832.9	796.2
Rainfall	1997-98	792.5	693.4	804.2	632.1	730.5
Rainfall	1998-99	1081.9	868.9	1050.9	942.7	986.1
Rainfall	1999-2K	996.4	658.3	1020.3	651.9	831.7
Rainfall	2000-01	783.7	817.6	954.3	722.7	819.6
Rainfall	2001-02	783.7	817.6	954.3	722.7	819.6

Rainfall in Rabi Season

Rabi		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
rainfall	1980-81	24.2	29.4	34.8	56.7	36.3
rainfall	1981-82	44.6	59.0	36.9	54.3	48.7
rainfall	1982-83	59.1	39.6	43.2	54.9	49.2
rainfall	1983-84	106.2	117.4	108.6	79.1	102.8
rainfall	1984-85	4.5	28.4	26.9	6.6	16.6
rainfall	1985-86	232.4	237.5	118.4	165.7	188.5
rainfall	1986-87	55.3	61.5	75.1	43.4	58.8
rainfall	1987-88	81.7	70.8	74.8	23.9	62.8
rainfall	1988-89	20.1	73.0	57.6	46.4	49.3
rainfall	1989-90	17.3	45.5	42.9	77.3	45.8
rainfall	1990-91	26.8	30.7	30.5	43.2	32.8
rainfall	1991-92	25.3	40.3	15.6	46.7	32.0
rainfall	1992-93	57.2	85.4	69.2	66.7	69.6
rainfall	1993-94	38.0	28.0	39.2	32.9	34.5
rainfall	1994-95	13.4	25.7	29.5	35.6	26.0
rainfall	1995-96	54.2	76.0	97.5	63.4	72.8
rainfall	1996-97	62.6	66.3	80.8	24.3	58.5
rainfall	1997-98	147.0	131.8	83.1	122.0	121.0
rainfall	1998-99	10.6	47.5	45.7	106.5	52.6
rainfall	1999-2K	39.4	63.5	60.6	54.6	54.6
rainfall	2000-01	53.4	65.4	77.6	64.2	65.1
rainfall	2001-02	53.4	65.4	77.6	64.2	65.1

Source: Department of Agricultural Statistics, Uttar Pradesh

One also sees an association between the growth rate of output and use of inputs like fertiliser and area under irrigation for UP as a whole and in various regions of UP, although in this case the relationship is not as strong as for yield levels. As noted earlier, compared with the period 1991-92 to 2001-02, the growth rate of crop output and crop yields recorded a significant growth in almost all the regions of UP during 1980-81 to 1991-92. During this period, per hectare consumption of fertilisers also increased from 52 kg per hectare to 87 kg per hectare for UP as a whole. Again, there was a substantial increase in the percentage of Gross Cropped Area under irrigation from 47 percent in 1981 to 62.45 percent in 1991.

Again during the period 1980-81 to 1991-92, the high growth rate regions of UP were the eastern, the central and the western region, in that order. These very regions also recorded a very high rate of growth in the use of fertilisers while area under irrigation did not show a very big change over this period.

3.5 Trend Growth Rate of Area Yield and Output of Major Crops

The new agriculture technology which was introduced during the mid sixties was confined to the western region of UP in the beginning. It spread widely across the state over time and has led to significant growth in agricultural output. Despite considerable inter regional variations, almost whole of Uttar Pradesh shared the gains of the new technology.

There were important changes during the various sub periods in the pattern of agricultural development. During the first phase of the green revolution, the new technology was confined to wheat and the main beneficiary was the western region. The new technology had hardly any impact on rice. The second period, i.e. 1970-71 to 1980-81, is characterised by the extension of the seed fertiliser technology from wheat to rice and its spread from western region to the eastern and the central region of UP. In the matter of growth of agricultural output , the period 1980-81 to 1991-92 marks a turning point in UP's agricultural development. However, in the post liberalisation period, the agricultural growth has declined.

Table 3.5 gives the trend growth of area, yield and output of major crops. Taking the entire period 1950-51 to 2001-02, food grain production increased at a rate of 2.98 percent. The growth in the western region was the highest at 3.29 percent, followed by eastern (3.12 percent) central (2.77 percent) and Bundelkhand regions (2.03 percent).

The agriculture growth during the first few decades after independence was biased in favour of the western region of the state. This scenario has undergone perceptible changes. During the 1960s, food grain production in the state grew at a rate of 1.89 percent. The growth in the western region was the highest at 3.76 percent followed by the eastern region at 2.27 percent. Compared to the 60s, all the regions of the state showed lower rate of growth in the subsequent decades. UP as a

Table 3.5

Trend Growth Rates of Area, Production and Yield :1950-51 to 2001-2002

	1960-61 to 1970-71			1970-71 to 1980-81			1980-81 to 1991-92			1992-93 to 2001-02			1950-51 to 2001-02		
	Area	Prod	Pvty	Area	Prod	Pvty	Area	Prod	Pvty	Area	Prod	Pvty	Area	Prod	Pvty
1.All foodgrains															
Bundelkhand	1.13	1.29	0.12	0.02	-0.61	-0.65	0.09	1.70	1.49	1.31	3.32	1.68	0.71	2.03	1.42
Central	-0.21	1.98	2.14	0.11	1.71	1.53	-0.14	3.60	3.71	0.38	2.43	2.16	0.32	2.77	2.49
Eastern	0.29	2.27	1.99	0.29	2.01	1.54	0.35	4.50	4.03	0.49	2.67	2.21	0.50	3.12	2.66
Western	0.38	3.76	3.31	-0.08	2.24	2.27	-0.40	3.15	3.49	0.68	2.66	2.01	0.37	3.29	3.00
Uttar pradesh	0.34	2.69	2.30	0.16	1.89	1.59	0.03	3.55	3.48	0.22	2.28	2.08	0.45	2.98	2.62
2. Wheat															
Bundelkhand	1.91	3.66	1.71	0.79	0.31	-0.59	-0.60	1.52	2.28	1.27	4.41	2.95	1.56	3.42	2.09
Central	1.86	5.32	3.32	3.46	6.47	2.63	0.40	3.51	3.19	1.08	3.06	2.37	2.77	5.28	2.82
Eastern	3.56	7.91	4.36	5.98	7.92	1.94	1.60	4.30	2.92	1.07	2.67	1.70	4.08	6.42	2.87
Western	3.01	7.82	4.72	2.29	4.79	2.28	0.30	3.20	2.86	0.90	2.92	2.22	2.20	4.93	3.07
Uttar pradesh	2.91	7.01	3.99	3.12	5.32	1.91	1.03	3.40	2.85	0.66	2.66	2.18	2.72	5.14	2.82
3. Rice															
Bundelkhand	0.76	2.38	1.61	1.11	0.88	-0.32	-2.54	0.69	1.85	1.66	6.24	3.32	0.55	1.49	1.48
Central	-0.18	0.99	1.08	1.63	3.36	1.38	-0.24	5.50	5.27	1.40	2.85	1.10	1.25	3.91	2.76
Eastern	0.23	1.68	1.36	1.02	3.09	1.89	0.42	6.50	5.82	0.90	3.70	2.74	0.85	3.92	3.15
Western	2.13	3.12	0.82	1.73	5.24	3.42	0.08	5.40	4.87	3.50	3.87	0.10	1.76	4.96	3.22
Uttar pradesh	0.41	1.53	0.93	1.60	3.98	2.36	0.18	5.70	5.22	1.26	3.12	1.69	1.07	3.97	2.98

Source: Department of Agricultural Statistics, Uttar Pradesh

Note: * denotes insignificant result.

registered a growth rate in food grain production of 1.89 percent during 1970-80. Again, western region registered the highest rate of growth of 2.24 percent per annum during the 70s followed by the eastern region at 2.01 percent. In terms of food grain productivity growth, the performance of the western region was the best during the 60s and 70s.

The performance of two major food grains has shown dissimilar developments. While productivity increase in wheat has been the highest in the western region in the 60s and the 70s, production has grown at a significantly higher rate in the eastern region led by higher area increase. The other regions also showed signs of catching up. In case of rice, the western region led both in terms of production and productivity growth in the 70s.

UP as a whole registered a growth rate in food grain production of 4.5 percent during 1980-81 to 1991-92. The eastern region, because of high productivity growth and increase in area, registered the highest rate of growth (4.5 percent) per annum during the 80s followed by the central region (3.60 percent) and the western region (3.15 percent). The trend growth rate in food grain production in the subsequent decade (1991-92 to 2001-02) declined to 2.28 percent (highest in the Bundelkhand region at 3.32 percent followed by the eastern region at 2.67 percent, the western region at 2.66 percent and the central region at 2.43 percent).

In terms of food-grain productivity growth, the performance of western region was the best during 1950-51 to 2001-02. However, during the period 1980-81 to 1991-92, trend growth rate in productivity has been the highest in the eastern region. In the pre-liberalisation period, food grain productivity growth in the eastern region was 4.03 percent as compared to 3.71 percent in the central region and 3.49 percent in the western region. In the post liberalisation period, food grain productivity growth has declined for all the regions. The Bundelkhand region was the only exception where food-grain productivity growth has increased.

The performance in terms of the two major food grains has shown different developments. While productivity increases in wheat have been the highest in the western region during the period 1950-51 to 2001-02, production has grown at a

significantly higher rate in the eastern and the central region. The same trend was observed during 1980-81 to 1991-92. While productivity increases in wheat have been the highest in the central region, production has grown at a significantly higher rate in the eastern region, led by higher area increases. In the post liberalisation period, the trend growth rate of area, production and yield for wheat have declined for all the regions except the Bundelkhand region.

Table 3.6

Trend Growth Rates of Area, Production and Yield :1980-81 to 2001-2002

	1980-81 to 2001-02			1980-81 to 1991-92			1992-93 to 2001-02		
	Area	Prod	Pvty	Area	Prod	Pvty	Area	Prod	Pvty
1. Tot Cereals									
BUNDELKHAND	-0.76	2.62	3.28	-1.69	1.13	2.70	0.16	3.81*	3.37*
CENTRAL	0.31	3.18	2.87	-0.21	4.00	4.10	0.84	2.71	1.95
EASTERN	0.61	3.63	3.26	-0.48	4.80	4.34	0.73	2.90	2.17
WESTERN	0.32	3.00	2.59	-0.43	3.40	3.68	1.07	2.87	1.82
UTTAR PRADESH	0.18	3.05	2.91	0.00	3.80	3.81	0.39	2.49	2.12
2.Pulses									
BUNDELKHAND	3.30	3.38	0.33*	4.21	4.86	0.12*	2.39	2.40*	-0.44*
CENTRAL	-2.39	-2.81	0.38*	-2.32	-2.60	-0.13*	-2.48	-1.41*	1.59
EASTERN	-0.77	-0.44	0.32*	0.00	0.63	0.83	-1.51	-1.48*	0.35
WESTERN	-3.46	-3.93	0.07*	-1.78	-0.81	1.11*	-5.15	-6.30*	-0.98
UTTAR PRADESH	-0.22	-0.45	0.06*	0.33	0.65	0.32	-0.78	-0.83*	0.00
3.Tot Oilseeds									
BUNDELKHAND	4.55	7.76	3.21	0.52	8.50*	8.03	0.36	2.61*	2.00
CENTRAL	2.29	3.84	1.55	-2.00	3.60	5.64	-0.51	-3.26*	-4.09
EASTERN	1.57	4.25	2.68	0.44	6.50	6.16	0.57	1.08*	1.41
WESTERN	0.79	3.24	2.45	2.78	7.79	5.02	-6.65	-4.90	1.77
UTTAR PRADESH	1.76	4.08	2.33	1.76	7.74	5.98	-3.36	-3.08	0.34
4.Potato									
BUNDELKHAND	-2.32	0.11	1.38	-1.90*	-0.32	1.22	-2.70	0.70	3.85
CENTRAL	1.11	3.28	1.29	1.90	4.12	1.45	0.23	3.38	3.25
EASTERN	0.79	2.78	1.40	1.60	5.90	3.53	-0.11	2.32	3.18
WESTERN	3.25	4.39	1.63	3.60	4.80	0.96	2.85	6.58	4.01
UTTAR PRADESH	1.79	3.79	1.62	2.39	4.67	1.82	1.20	4.65	3.85
5.Sugarcane									
BUNDELKHAND	4.40	3.88	1.10*	2.96	3.80*	1.22	5.85	6.77	1.28*
CENTRAL	3.68	5.12	1.76	4.19	6.27	1.95	3.18	4.29	0.76
EASTERN	0.76	1.85	1.13	0.59	2.39	1.91	0.94	0.64	-0.41
WESTERN	1.11	2.62	1.48	1.52	3.65	2.33	0.70	0.43	-0.35
UTTAR PRADESH	1.34	2.78	1.38	1.80	3.76	2.10	0.80	0.76	-0.24

Source: Department of Agricultural Statistics, Uttar Pradesh

Note: * denotes insignificant results.

In the case of rice, the western region led both in terms of production and productivity growth during the period 1950-51 to 2001-02 but in the 80s, eastern region registered the highest growth in both production and productivity. In the post liberalisation period, the Bundelkhand region recorded the highest growth in production and productivity for both wheat and rice.

During the period 1980-81 to 2001-02, total cereals production increased at a rate of 2.98 percent (table 3.6). The trend growth rate in the eastern region was the highest at 3.63 percent followed by the central region (3.18), the western region (3.20 percent) and the Bundelkhand region (2.62 percent).

The state as a whole registered a growth rate of 3.8 percent in cereals production during 1980-81 to 1991-92. The eastern region recorded the highest rate of growth (4.8 percent) during the 80s, followed by the central region (4.00), the western region (3.15 percent) and the Bundelkhand region (1.13 percent). The trend growth rate in cereals production in the subsequent decade (1991-92 to 2001-02) declined to 2.49 percent (Highest in Bundelkhand region at 3.32 percent followed by the eastern region at 2.55 percent).

In terms of total cereals productivity growth, the performance of eastern region was the best during 1980-81 to 2001-02. However, in the post liberalisation period, the Bundelkhand region recorded the highest growth in cereals productivity.

During the period 1980-81 to 2001-02, pulse production declined at a rate of 0.45 percent. The decline in the western region was highest at 3.93 percent, followed by the central region (2.81 percent) and the eastern region (0.44 percent). However, the Bundelkhand region recorded the trend growth of 3.38 percent.

The state as a whole registered a growth rate in pulse production of 0.65 percent during 1980-81 to 1991-92. The Bundelkhand region, because of increase in area, registered the highest growth (4.86 percent) per annum during the pre liberalisation period followed by the eastern region. The trend growth rate has declined in the central and the western region in the preliberalisation period. In the post liberalisation period, pulse production in the Bundelkhand region, the central region, the eastern region and UP as whole do not show any secular trend.

However, the western region registered the trend growth of 2.87 percent during the period 1992-93 to 2001-02 because of productivity growth and increase in area.

During the period 1980-81 to 2001-02, total oilseeds production increased at a rate 4.08 percent. The growth in the Bundelkhand region was the highest at 7.76 percent, followed by the eastern region (4.28 percent), the central region (3.84 percent) and the western region (3.24 percent).

UP as a whole registered the trend growth rate in oilseed production of 7.74 percent during the period 1980-81 to 1991-92. The Bundelkhand region, because of increase in area and productivity growth, registered the highest rate of growth (8.5 percent) during the pre liberalisation period, followed by western (7.79 percent), eastern (6.16 percent) and central regions (3.6 percent).

The trend growth rate in oilseeds production in the subsequent decade (1991-92 to 2001-02) was negative. Only the Bundelkhand and the eastern region registered positive trend growth.

In term of total oilseeds productivity growth, the performance of the Bundelkhand region was the best during 1980-81 to 2001-02. In the pre liberalisation period, oilseed productivity growth in the bundelkhand region was 8.03 percent as compared to 6.16 percent in the eastern region and 5.64 percent in the central region.

In the post liberalisation period oilseeds productivity growth does not shows any secular trend and the whole period was filled with fluctuations.

During the period 1980-81 to 2001-02, potato production increased at a rate of 3.79 percent. The growth in the western region was the highest at 4.39 percent, followed by the central region (3.28 percent), the eastern region (2.78 percent) and the Bundelkhand region (.11 percent).

The state as a whole registered a growth rate in potato production of 4.67 percent during 1980-81 1991-92. The eastern region, mainly because of increase in area (3.53 percent), registered the highest rate of growth (5.90 percent) during the preliberalisation period, followed by the western region (4.80 percent) and the

central region (4.12 percent). The trend growth rate in the subsequent decade declined to 4.67 percent (highest in the western region at 6.58 percent, followed by the central region at 3.38 percent and the eastern region 2.32 percent). In terms of potato productivity western region was the best during 1980-81 to 2001-02.

During the period 1980-81 to 2001-02, sugarcane production increased at a rate of 2.78 percent. The growth in the central region was the highest at 5.12 percent, followed by the bundelkhand region (3.88 percent), the western region (2.62 percent) and the eastern region (1.85 percent). The state as a whole registered a growth rate of 3.76 percent during the pre liberalisation period. The central region, because of increase in area, registered the highest rate of growth (6.27 percent) per annum during the 80s, followed by the western region (3.65 percent) and the eastern region (2.39 percent). The trend growth rate in sugarcane production in the subsequent decade (1991-92 to 2001-02) declined to .76 percent (highest in Bundelkhand at 6.77 percent followed by the central region at 4.29 percent). In terms of sugarcane productivity growth, the performance of the central region was the best during the period 1980-81 to 2001-02.

However, yields (for both food grains and non-food grains) are still the highest in western region (table 3.2). Nevertheless, since 1980-81, the gap between the eastern and central region on the one hand and the western region on the other hand has narrowed down. In the earlier phases, the western region witnessed a faster growth in agricultural output due to the use of modern inputs. In recent years, the new agricultural strategy spread to the eastern and the central regions of UP where use of modern inputs increased greatly, where as inputs did not grow as fast in the western region.

Finally, one can say that the growth in crop production in the post liberalisation period declined for all the regions. The only exception was the Bundelkhand region where the acceleration in production has taken place.

The most important factor responsible for the decline of inter-regional differences is the public investment in agriculture, particularly in irrigation.[7]

3.6 Cropping Pattern Changes During 1980-81 To 2001-02

By cropping pattern we mean the proportion of area under different crops at a point of time, changes in this distribution of area over a period of time, and factors determining this change in distribution. The cropping pattern in India is determined mainly by natural factors like rainfall, climate and soil condition. However, prices of agricultural commodities, income of farmers, size of holdings, availability of agricultural inputs, and nature of land tenure have also played an important part. For example, increase in prices of a certain crop consistently for some years in relation to other crops can induce the farmers to shift over to that crop. for instance, farmers growing pulses and inferior cereal like jowar, bajra and maize have been tempted to shift over to the production of wheat in recent years on account of price factors and also on account of the higher productivity potential of new high yielding. Variety of wheat the size of farm holdings also affects the crop pattern. Small farmers give first priority to food crops because they are more interested in fulfilling their food requirements in the first instance as against this, large farmers with substantial holdings may tend to denote a part of their land for growing cash crops.[8]

Most of the regions have almost 70 percent of their area under food crops. In 2001-02, the Bundelkhand region had the highest with 92.74 percent of its gross cropped area under food grains, followed by the eastern region (89.74 percent), the central region (78.87 percent) and the western region (68.99 percent).

Inter temporal comparison shows that the percentage of area under food crops has declined in almost all the regions during 1980-81 to 2001-02. In case of western region, it declined from 73.15 percent in 1980-81 to 68.99 percent in 2001-02. Similarly, in case of the central region, it declined from 85.63 percent in 1980-

[7] Srivastava: unequal partner

[8] Leena D, 1998.

81 to 78.87 percent in 2001-02. In the Bundelkhand region, the decline was from 94.3 percent to 92.74 percent.

Cropping Pattern Changes-Region Wise

The eastern region experienced the minimum decline in area under food crops. In the eastern region, the area under food crops declined from 89.94 percent to 89.74 percent during the period 1980-81 to 2001-02.

Thus, in all the regions, there is a shift towards non-food commercial crops over time (Table 3.7). However, the shift towards commercial crops is not much.

The analysis of area under major crops shows that in 2001-02, the eastern region has the largest proportion of its gross cropped area under rice cultivation. It was 36.93 percent. Other regions having high proportion of gross cropped area under this crop are the central and the western region. Proportion of area under rice cultivation has increased during 1980-81 to 2001-02 in case of the western region, the eastern region and the central region. Decline in the proportion of area under rice has taken place in case of the Bundelkhand region.

The analysis of area under wheat shows that the eastern region has the highest proportion of gross cropped area under wheat cultivation. It was 37.96 percent in 2001-02, followed by the central region at 36.64 percent, the western region at 36.54 percent and the Bundelkhand region at 29.21 percent.

Proportion of area under wheat cultivation has increased during the entire period in case of the western region, the central region and the eastern region. However, in the Bundelkhand region the cropping pattern is shifting away from wheat.

The proportion of area under total cereal cultivation has been the highest in case of the eastern region. It was 81.41 percent in 2001-02. The central region is another major cereals growing region which has 69.53 percent of its area under this crop. In comparison with 1980-81, the area under total cereals has declined in the central region, the Bundelkhand region, and the western region. However, the eastern region has registered an increase in area.

In case of pulses, the Bundelkhand region has the highest proportion of gross cropped area under these crops. It was 50.32 percent in 2001-02. Other important pulse growing regions are the central region (9.34 percent), the eastern region (8.33 percent) and the western region (3.41 %). Area under pulses has significantly declined in case of the central region, the western region and the eastern region. In case of the central region, the proportion of area under pulses has declined from 16.79 percent in 1980-81 to 9.34 percent in 2001-02.

Major commercial crops in UP includes sugar cane, oilseed etc. The western region has the largest area under sugar cane. It accounted for 12.95 percent of its gross cropped area in 2001-02, followed by the central region (8.56percent), the eastern region (4.31 percent) and the Bundelkhand region (0.31 percent). Compared to 1980-81, the area under sugarcane has increased in all the regions.

In case of total oilseeds, the Bundelkhand region has the highest proportion of gross cropped area under these crops. It was 5.46 percent in 2001-02, followed by the central region (4.88 percent), the western region (3.52 percent) and the eastern region (1.59 percent). Proportion of area under oilseeds cultivation has increased during the entire period in case of the Bundelkhand and the eastern region. Regions in which cropping pattern has shifted away from oilseeds include the central and the western region.

In case of potato, the western region has the largest area under this crop that accounted for 2.30 percent of its gross cropped area in 2001-02, followed by the central region at 1.32 percent, the eastern region at 1.32 percent and the Bundelkhand region at 0.05 per cent. During the period 1980-81 to 2001-02, area under this crop has increased in all the regions except the Bundelkhand region where the area under the crop has declined.

Table3.7

Cropping Pattern Changes-Region Wise

Region\ Period	RICE	Wheat	Tot Cereals	Pulses	Food - grains	Non Food-grains	Oil-seeds	Sugar-cane	Tobacco	Onion	Potato	Gram
BUNDELKHAND												
1980-81	5.17	30.62	56.68	29.82	94.30	5.70	3.92	0.11	0.01	0.02	0.08	25.98
1992-93	4.05	28.72	46.56	44.85	91.40	8.60	6.77	0.22	0.00	0.03	0.08	21.93
2001-02	4.18	29.21	42.42	50.32	92.74	7.26	5.46	0.31	0.00	0.03	0.05	23.51
CENTRAL												
1980-81	23.38	34.36	72.68	16.79	85.63	14.37	5.07	3.81	0.04	0.09	1.10	6.95
1992-93	23.15	34.80	67.78	12.65	80.44	19.56	5.53	6.56	0.02	0.11	1.52	4.37
2001-02	25.23	36.64	69.53	9.34	78.87	21.13	4.88	8.56	0.02	0.09	1.32	2.40
EASTERN												
1980-81	34.64	31.68	79.43	10.37	89.94	10.06	0.94	3.32	0.01	0.12	1.08	5.23
1992-93	34.79	36.01	78.94	10.28	89.22	10.78	1.63	3.88	0.01	0.12	1.34	3.35
2001-02	36.93	37.96	81.41	8.33	89.74	10.26	1.59	4.31	0.03	0.11	1.18	1.54
WESTERN												
1980-81	12.29	34.19	65.80	7.52	73.15	26.85	4.63	9.86	0.14	0.13	1.35	2.70
1992-93	12.24	35.08	61.95	5.08	67.03	32.97	5.92	12.43	0.13	0.19	1.99	1.12
2001-02	16.15	36.55	65.58	3.41	68.99	31.01	3.52	12.95	0.18	0.07	2.30	0.42
UTTAR PRADESH												
1980-81	20.42	31.49	71.66	11.64	83.30	16.70	3.45	5.40	0.06	0.10	1.05	6.07
1992-93	20.32	33.29	68.05	11.38	79.43	20.57	4.38	7.03	0.06	0.13	1.45	4.14
2001-02	23.86	36.37	69.61	10.55	80.16	19.84	3.28	8.00	0.08	0.08	1.53	3.30

Source: Department of Agricultural Statistics, Uttar Pradesh

3.7 Crop Diversification

Crop diversification is a concept which is opposite to crop specialisation. Crop diversification, in terms of percentage of gross cropped area under different crops, has been analysed in terms of Gini coefficient and Entropy indices[9]. In 1980-81, the gini coefficient for the Bundelkhand, the central, the eastern and the western region were 0.46, 0.47, 0.52 and 0.46 respectively. However, this figure declined for the

Table3.8
Gini Coefficients

	Bundelkhand	Central	Eastern	Western
1980-81	0.46	0.47	0.52	0.46
1981-82	0.45	0.45	0.52	0.44
1982-83	0.47	0.47	0.52	0.46
1983-84	0.46	0.47	0.52	0.47
1984-85	0.45	0.47	0.53	0.47
1985-86	0.45	0.47	0.53	0.46
1986-87	0.46	0.47	0.53	0.47
1987-88	0.46	0.47	0.53	0.48
1988-89	0.46	0.47	0.53	0.48
1989-90	0.44	0.47	0.53	0.48
1990-91	0.43	0.47	0.54	0.47
1991-92	0.44	0.48	0.54	0.48
1992-93	0.42	0.48	0.54	0.49
1993-94	0.42	0.49	0.54	0.49
1994-95	0.43	0.49	0.54	0.49
1995-96	0.42	0.49	0.54	0.48
1996-97	0.41	0.48	0.54	0.49
1997-98	0.41	0.49	0.55	0.49
1998-99	0.41	0.49	0.55	0.50
1999-2K	0.42	0.50	0.55	0.50
2000-01	0.41	0.50	0.56	0.51
2001-02	0.42	0.51	0.56	0.51

Source: Calculated from Area under Crops as Given by Department of Agricultural Statistics, Uttar Pradesh

[9] Higher the value of gini coefficient, higher is the specialization in the state. The value of entropy index varies from 0 to $\log_e N$. Higher the value of entropy indices, higher will be the level of diversification.

Table 3.9

Entropy Indices

	Bundelkhand	Central	Eastern	Western
1980-81	0.80	0.84	0.74	0.85
1981-82	0.83	0.87	0.75	0.89
1982-83	0.80	0.86	0.75	0.86
1983-84	0.82	0.85	0.75	0.85
1984-85	0.83	0.84	0.74	0.85
1985-86	0.83	0.85	0.74	0.87
1986-87	0.82	0.85	0.74	0.86
1987-88	0.83	0.86	0.74	0.85
1988-89	0.83	0.85	0.73	0.84
1989-90	0.86	0.85	0.73	0.84
1990-91	0.87	0.84	0.72	0.84
1991-92	0.87	0.84	0.72	0.82
1992-93	0.89	0.84	0.72	0.81
1993-94	0.89	0.83	0.72	0.81
1994-95	0.87	0.82	0.72	0.81
1995-96	0.89	0.82	0.72	0.81
1996-97	0.90	0.83	0.72	0.80
1997-98	0.90	0.82	0.71	0.79
1998-99	0.89	0.81	0.70	0.78
1999-2K	0.90	0.80	0.70	0.76
2000-01	0.91	0.80	0.69	0.75
2001-02	0.89	0.78	0.68	0.76

Source: Calculated from Area under Crops as Given by Department of Agricultural Statistics, Uttar Pradesh

Bundelkhand region (from 0.46 to 0.42) and increased for the central (0.47 to 0.51), the eastern (0.52 to 0.56) and the western region (0.46 to 0.51). This means that specialisation has taken place in the central, eastern and the western region where as diversification has taken place in the Bundelkhand region.

In 1980-81, the entropy indices for the Bundelkhand, the central, the eastern and the western region were 0.80, 0.84, 0.74 and 0.85 respectively. However, this figure increased for the Bundelkhand region (from 0.80 to 0.89) and declined for the central (0.84 to 0.78), the eastern (0.74 to 0.68) and the western region (0.85 to

0.76). This means that specialisation has taken place in central, eastern and western regions whereas diversification has taken place in the Bundelkhand region.

Gini co-efficients and entropy indices (table 3.8 and 3.9) show that Bundelkhand region has relatively diversified cropping pattern. However, the regions like the central, the eastern and the western region have cropping pattern concentrated around a few crops.

3.8 Crop Concentration

Co-efficient of localisation is used to capture the spread of a particular crop across districts or regions. Higher value of a coefficient of localisation for a crop implies that particular crop is concentrated in few districts. Formula for the calculation of co-efficient of localisation has been written the first chapter.

Table3.10
Localisation Coefficient

	1980-81	1991-92	2001-02
WHEAT	0.245	0.249	0.247
RICE	0.264	0.258	0.257
ARHAR	0.238	0.267	0.271
BAJARA	0.327	0.321	0.338
BARLEY	0.256	0.274	0.266
GROUNDNUT	0.233	0.126	0.058
GRAM	0.234	0.222	0.189
JUAR	0.173	0.191	0.211
TOTAL MAIZE	0.304	0.315	0.313
MASOOR	0.182	0.202	0.247
TOTAL MOONG	0.104	0.295	0.225
PEA	0.320	0.203	0.135
POTATO	0.293	0.291	0.307
RICE	0.264	0.258	0.257
SUGARCANE	0.198	0.190	0.196
TIL (PURE)	0.140	0.149	0.098
TOBACCO	0.374	0.432	0.468
URAD	0.143	0.130	0.104

Source: Calculated from Area under Crops as Given by Department of Agricultural Statistics, Uttar Pradesh

To measure the level of concentration of a particular crop over the period 1980-81 to 2001-02, three points of time have been taken and co-efficient of localisation has been calculated at the three points. The three points are 1980-81, 1991-92 and 2001-02. The values of co-efficient of localisation have increased for wheat, Arhar, Bajra, Maize, Potato, tobacco etc. (table 3.10).

The increase in the value of co-efficient of localisation implies that over the period the concentration of these crops has increased across districts. For crops such as rice, groundnut, gram, pea, sugarcane, til, urad etc, the co-efficient of localisation has decreased. This implies that the spread of rice, groundnut, gram, pea, sugar cane, til, urad have increased over the period.

Moong and tobacco are two crops whose co-efficient of localisation has increased over the period which implies that their concentration has increased over the period 1980-81 to 2001-02. Tobacco has the maximum valve (.374) for co-efficient of localisation in the year 1980-81. The lowest valve of co-efficient of localisation is for total moong. Tobacco has remained the most region specific or most concentrated crop in the year 1991-92 but the place of moong as the crop having maximum spread across districts has been taken over by urad in 1991-92.

Tobacco continues to maintain its position of most concentrated crop in 2001-02 but the position of urad as the crop having maximum spread across districts has been taken over by the groundnut.

3.9 Relative Crop Shares in Value of Output:

Major changes in cropping pattern are also reflected in changes in the share of various crops in the total value of output during 1980-81 to 2001-02. During 1980-81 to 2001-02, there was a perceptible decline in the share of food grains in the total value of output from 69.07 percent in 1980-81 to 66.05 percent in 2001-02 (Table 3.11). On the other hand, the share of non-food grains in total value of output recorded a notable increase. Among the non-food grains, share of potato and tobacco increased marginally and that of sugar cane remained almost constant.

Table 3.11

Share of Various Crops in Total Output of Regions

Region\ period	Rice	Wheat	Tot Cereals	Pulses	Food grains	Non Food grains	Oil seeds	Ground nut	Soyabean	Sunflower	Sugar cane	Arhar	Gram	Toba-cco	Potato
Bundelkhand															
1980-81	3.57	33.08	46.66	51.71	98.36	1.64	0.26	0.17	0.09	0.01	0.56	15.73	35.97	0.06	0.78
1992-93	4.79	42.51	55.13	43.28	97.40	2.60	0.74	0.43	0.79	0.02	0.75	9.65	29.63	0.03	0.53
2001-02	4.88	47.05	55.88	41.42	97.29	2.71	0.94	0.57	0.47	0.01	0.83	5.16	31.25	0.04	0.44
Central															
1980-81	19.06	36.47	62.80	17.38	80.18	19.82	1.52	1.48	0.00	0.03	14.48	7.82	9.56	0.16	5.15
1992-93	24.70	32.26	63.96	7.90	71.87	28.13	2.27	1.99	0.00	0.28	23.17	3.86	4.05	0.27	4.41
2001-02	24.11	35.15	62.91	4.73	67.64	32.36	0.61	0.51	0.00	0.10	26.78	2.73	2.00	0.24	5.24
Eastern															
1980-81	29.31	32.23	66.64	13.16	79.80	20.20	0.34	0.33	0.00	0.01	14.98	6.25	6.91	0.04	5.17
1992-93	35.43	34.02	73.40	6.67	80.07	19.93	0.28	0.24	0.00	0.04	14.81	3.47	3.21	0.18	4.90
2001-02	39.79	34.94	77.43	3.43	80.87	19.13	0.16	0.14	0.00	0.01	13.74	2.25	1.18	0.37	5.01
Western															
1980-81	10.82	31.06	50.28	4.91	55.19	44.81	1.19	1.17	0.01	0.02	38.20	2.55	2.36	0.51	6.07
1992-93	12.20	31.65	50.98	1.75	52.73	47.27	0.59	0.30	0.00	0.29	40.11	0.90	0.86	1.33	5.54
2001-02	13.78	32.80	51.72	0.84	52.56	47.44	0.15	0.10	0.00	0.05	36.20	0.56	0.28	1.95	9.25
Uttar pradesh															
1980-81	17.99	32.38	57.64	11.42	69.07	30.93	0.98	0.88	0.08	0.02	25.25	4.96	6.46	0.28	5.30
1992-93	21.48	32.86	60.53	5.75	66.28	33.72	0.96	0.63	0.13	0.19	27.72	2.48	3.27	0.73	4.93
2001-02	23.25	34.54	62.08	3.97	66.05	33.95	0.40	0.33	0.02	0.04	25.98	1.68	2.30	1.07	6.83

While the share of wheat and rice rose significantly, there was a substantial decline in the share of pulses. Share of pulses declined from 11.42 percent in 1980-81 to 3.97 percent in 2001-02.

In the eastern region, despite a decline in the value of pulses, the value of output of food grains registered an increase. On the other hand, there was a counter balancing decline in the value share of sugarcane and potato.

In the western region, the share of food grains and sugarcane declined and that of potato and tobacco increased. The central region witnessed a sharp fall in the value of food grains, mainly pulses and wheat, and substantial rise in the value share of sugarcane. In the Bundelkhand region, the value share of food grains has remained almost the same. However, Bundelkhand registered a sharp decline in the share of pulses and a substantial rise in the share of wheat.

To sum up, there has not been much change in the cropping pattern during the period 1980-81 to 2001-02, in terms of both area allocation and share in total value of output. . Inter temporal comparison shows that the percentage of area under food crops has declined in almost all the regions during 1980-81 to 2001-02. In all the regions, there is a shift towards non-food commercial crops over time. However, the shift towards commercial crops is not much.

3.10 Changes in Agricultural Labour Force and Labour Productivity

One of the major structural problem of UP's economy is the very slow rate of diversification of labour force from agriculture to non-agricultural occupation. The productivity levels of agricultural workers have remained low, because of low yield and excessive population pressure on land.

Since the income and living standards of the agricultural population are ultimately determined by their productivity levels, it is worthwhile to study the nature of inter regional variation in the pattern of growth in male agricultural worker (MAW) productivity between 1980-81 to 2001-02. Male agricultural workers rather than total agricultural workers have been taken for our analysis since data on total agricultural workers is not available.

An inter-regional analysis of MAW productivity brings out that in 1980-81, the western region had the highest level of labour productivity followed by the bundelkhand, the central and eastern region (table 3.12A). Interestingly, Bundelkhand region has lower land productivity than central and eastern regions, but the Bundelkhand region has higher level of MAW productivity vis-à-vis the central region and the eastern region.

For UP as a whole, growth rate of agricultural output of 3.49 percent exceeded that of male agricultural workers of 1.6 percent per annum during 1980-81 to 1991-92. Consequently, for the state as a whole, MAW productivity increased at a rate of 2.33 percent per annum. During the pre liberalisation period, MAW productivity in the eastern region increased an annual rate of 3.15 percent followed by central region (2.85 percent) western region (2.10 percent).

The Bundelkhand region had a negative growth in its MAW productivity. This implies that in the slow growing Bundelkhand region, increase in output was eaten away by large increase in workforce, presumably because the growing workforce had no where else to go.

During the period 1991-92 to 2001-02, the central region, the eastern region and UP as a whole had negative growth in the male worker productivity. In the post liberalisation period, there had been a decline in the trend growth rate of agricultural output of all the regions but increase took place in the growth rate of male agricultural workers. (Table 3.12B) For the state as whole, the male agricultural workers grew at a rate of 3.43 percent where as output grew at a rate of 2.06 percent in the post liberalisation period, leading to negative growth in the male workers productivity. The western region, because of the slow growth rate in the number of agricultural workers, recorded the 0.73 percent of growth in the workers' productivity.

To sum up, the result in MAW productivity brings out the dimension of change that took place as a result of the pattern of growth of agriculture during 1980-81 to 2001-02. An important inference of this development is that during the post liberalisation period, due to lack of employment opportunities in the non-agricultural sector, number of

Table3.12A

Region wise Levels and Trend Growth of Male Agri Workers Productivity

Sl no	Region	Male Workers Productivity				Trend Growth Rate*		
		1980-81	1991-92	2001-02		A	B	C
1	BUNDELKHAND	5313.66	4256.66	4522.57		-2.19	0.61	-0.80
2	CENTRAL	4811.35	6372.50	6216.70		2.85	-0.25	1.29
3	EASTERN	4589.58	6260.78	4615.00		3.15	-3.00	0.03
4	WESTERN	7966.20	9807.83	10552.80		2.10	0.73	1.42
	UTTAR PRADESH	6127.95	7715.90	6667.20		2.33	-1.45	0.42

Source: Estimated from Area under Crops as Given by Department of Agricultural Statistics, Uttar Pradesh

* Percent Trend Growth Rate
(A)1980-81 to 1991-92
(B) 1992-93 to 2001-02
(C) 1980-81 to 2001-02

Table3.12B

Region wise Growth of Agri Output and Agri Workers During 1980-81 to2001-02

Sl no	region	Trend Growth Rate of Agri output*				Growth Rate of Agric Workers*		
		A	B	C		A	B	C
1	BUNDELKHAND	1.29	-0.11	2.84		2.26	3.90	3.08
2	CENTRAL	3.02	3.83	2.75		134	3.13	2.23
3	EASTERN	3.01	4.21	2.63		1.50	5.27	3.37
4	WESTERN	2.84	3.43	2.15		1.74	1.25	1.19
	UTTAR PRADESH	2.75	3.49	2.06		1.60	3.43	2.51

Source: Estimated from Area under Crops as Given by Department of Agricultural Statistics, Uttar Pradesh

* Percent Trend Growth Rate
(A)1980-81 to 1991-92
(B) 1992-93 to 2001-02
(C) 1980-81 to 2001-02

workers in agricultural sector increased during the period 1991-92 to 2001-02. There has also been a decline in agricultural growth in the post liberalisation period. As a result, the central region, the eastern region and UP as a whole had negative growth in the male agricultural worker productivity.

3.11 Conclusion

The new agricultural technology which was introduced during the mid sixties was confined to the western region of UP in the beginning. It spread widely across the state over time and has led to significant growth in agriculture output. Despite considerable inter regional variations, almost whole of the Uttar Pradesh shared the gains of the new technology.

There were important changes during the various sub periods in the pattern of agricultural development. During the first phase of the green revolution, i.e. in mid 60s, the new technology was confined to wheat and the main beneficiary was the western region. The new technology had hardly any impact on rice. The second period from 1970-71 to 1980-81 is characterised by the extension of the seed fertiliser technology from wheat to rice and its spread from western region to the eastern and the central region of UP. It has been found that the Bundelkhand region had done reasonably well in the post liberalisation period vis-à-vis other regions. It was also revealed that during the period 1980-81 to 2001-02, yield growth had become the predominant source of output and the contribution of area growth to growth of output had perceptibly declined in all the regions.

Another notable development is that there has not been much change in the cropping pattern during the period 1980-81 to 2001-02. There has been only a marginal shift from coarse cereals towards wheat and rice. Inter temporal comparison shows that the percentage of area under food crops has declined in almost all the regions during 1980-81 to 2001-02. In all the regions, there is a shift towards non-food commercial crops over time. However, the shift towards commercial crops is not much. Gini co-efficients and entropy indices show that the Bundelkhand region has relatively diversified cropping pattern. Nevertheless, regions like the central, the eastern and the western region have cropping pattern concentrated around a few crops.

Finally, during 1980-81 to 1991-92, there was a marked rise in male agricultural worker productivity in the crop sector across all the regions. This was a major development in pre liberalisation decade since the income and living standards of the agricultural population is ultimately determined by their productivity levels. However, in the post liberalisation period, the central region, the eastern region and UP as a whole had negative growth in the male worker productivity.

CHAPTER-IV

Agriculture at the District Level

This chapter is devoted to a study of the inter-regional variations in productivity and the changes over time at the disaggregated district level. The purpose is to understand the spatial pattern of change and to identify the main elements of differences in yield levels by using districts as units of analysis.

The study covered the period from 1980-81 to 2001-02. Our analysis have taken into consideration the 48 old undivided districts as the unit of study because the study of the year starts from 1980-81, at which point of time the number of districts in UP were 48.

4.1 Regional Variation in Yield

The performance of UP agriculture at the district level has been studied by first combining various districts according to their yield levels (in value terms at constant 1990-93 prices) and then by looking at the changes in the shares of area and output under each category over the two periods of time. Secondly, the association between the productivity levels of various categories and use of various inputs like irrigation, fertiliser, rainfall, number of male agriculture workers etc. is enquired for the two periods namely 1980-81 to 1991-92 and 1991-92 to 2001-02.

This is followed by a detailed analysis of a spatial pattern of districts according to their yield levels and changes therein over the two periods. All the 48 districts have been divided into the following three categories on the basis of their per hectare (GCA) value of output

(i) Low productivity districts with yield less than Rs. 5000/- Hect;

(ii) Medium productivity district with yield ranging between Rs.5000-8000 and- Hect. And

(iii) High productivity district where yield levels exceed Rs. 8000/- Hect.

4.2 Disparities in Levels of Development

Table 4.1 gives details about the distribution of district according to yield levels in 1980-83, 1990-93 and 1999-2002. These periods have been named as 1981, 1991 and 2001 hereafter. In 1981, in 22 districts out of the total 48 districts, accounting for 46.8 per cent of area and 22.9 percent of output of 24 crops, productivity levels were less than Rs.5000/ Hect. (Low productivity category). 19 districts with 37.91 percent of area and 26.3 percent of output had medium productivity ranging between Rs.5000/- to Rs. 8000/- Hect. and as few as 7 districts accounting for 15.29 percent of area and 50.76 percent of output belonged to higher productivity category.

Table 4.1

Share of Districts in Area and Output by Productivity Levels in 1981, 1991, and 2001

Productivity Level*		No of districts			% Share in Area(24Crops)			% Share in Output of (24Crops)		
		1981	1991	2001	1981	1991	2001	1981	1991	2001
High	8000 and above	7	18	30	15.29	38.21	66.10	50.76	69.89	84.47
Medium	5000-8000	19	22	15	37.91	46.51	27.78	26.32	25.38	13.81
Low	less than 5000	22	8	3	46.80	15.28	6.12	22.92	4.73	1.73
overall		48	48	48	100	100	100	100	100	100

Source: Calculated from Area & Production as Given by Department of Agricultural Statistics, Uttar Pradesh

In 1981, the low productivity districts were spread all over UP. The low productive districts include all the 5 districts of the Bundelkhand region, 5 out of 9 districts of the central region, 8 out of 15 districts of the eastern region and 4 out of 19 districts of the western region (table 4.2).

The 19 medium productive districts were mostly concentrated in the central, the eastern and the western region. Of these 19 districts, 4 were located in the central region, 6 districts in the eastern region and 9 in the western region.

Table 4.2

Distribution of Districts in Different Regions by Levels of Productivity in 1980-81

Productivity Level (Rs./Hectare at 1990-93 prices)		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
High	8000 and above	0	0	1	6	7
Medium	5000-8000	0	4	6	9	19
Low	less than 5000	5	5	8	4	22
Overall		5	9	15	19	48

Source: Calculated from Production as Given by Department of Agricultural Statistics, Uttar Pradesh

Most of the high productivity districts were located in the western region. Out of 7 districts, 6 were located in the western region and only one in the eastern region.

To sum up, in 1981, most of the UP except western region was recording low to medium productivity levels. It was during the eighties that the new technology made significant headway and extended to both new areas and more crops.

A major development was the introduction of high yielding varieties of IR-8 rice for the first time leading to visible increase in rice yields and output in the central and the eastern region of UP. As a result, by 1991 agricultural development took place in a number of initially backward districts and consequently the share of high productivity districts in total output and area increased substantially. Thus, the number of low productivity districts declined from 22 in 1981 to 8 in 1991. Area of districts in the medium productivity category further increased from 37.91 percent in 1981 to 46.51 percent in 1991, their share of output declined from 26.3 percent in 1981 to 25.38 percent in 1991.

The number of districts with high productivity (above Rs. 8000/- hect.) increased from only 7 in 1981 to 18 in 1991. During 1991, the high productivity districts accounted for 40 percent of the area and 70 percent of the aggregate output. This remarkable increase in agriculture productivity has brought significant changes in its wake leading firstly to rise in income in almost all the districts of UP. This new development has laid the basis for rapid growth not only of agriculture but also of non-agricultural economy in

both rural and urban areas. Further, consequent to the spread of new technology to newer areas, there was a significant change in the spatial pattern of districts with varying levels of productivity during the period of 1981 to 1991. As noted, the number of the low productivity districts has come down from 22 in 1981 to 8 in 1991.

In 1991, the low productive districts included all the five districts of the Bundelkhand. The number of such districts has come down to two in the eastern region and only one in the western region as against 1981. Of 22 medium productivity districts, eight were located in the central region, 8 in the eastern region and 6 in the western region. As compared to just 7 in 1981, the number of high productivity districts had increased to 18 in 1991. The highest increase in the high productivity districts had taken place in the western region where their number increased from 6 in 1981 to 12 by 1991. The number of high productivity districts increased from 1 in 1981 to 5 by 1991 in the eastern region, and from 0 to 1 in the central region (table 4.2 and 4.3).

Table4.3

Distribution of Districts in Different Regions by Levels of Productivity in 1992-93

Productivity Level (Rs./Hectare at 1990-93 prices)		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
High	8000 and above	0	1	5	12	18
Medium	5000-8000	0	8	8	6	22
Low	less than 5000	5	0	2	1	8
Overall		5	9	15	19	48

Source: Calculated from Area & Production as Given by Department of Agricultural Statistics, Uttar Pradesh

There has been a significant change in the spatial pattern of districts with varying levels of productivity during the period 1991 to 2001. The number of districts in the low productivity category declined from 8 in 1991 to 3 in 2001. The number of districts in the

medium productivity category also declined from 22 in 1991 to 15 in 2001. While their share of area declined from 46.51 percent in 1991 to 27.78 percent in 2001, their share of output declined from 25.38 in 1991 to 13.80 percent in 2001. (Table 4.1). There was a significant increase in the number of high productive districts in 2001. The number of districts with high productivity increased from 18 in 1991 to 30 in 2001. In 2001, the high productivity districts accounted for 66 per cent of the area and 84 percent of the aggregate output.

During 2001, none of the low productivity districts was located in the central, eastern and the western region. However, three low productivity districts were located in the Bundelkhand region. Out of 15 medium productivity districts, one was located in the Bundelkhand region, five in the central region, 7 in the eastern region and two in the western region. As compared to 18 in 1991, the number of high productivity districts increased to 30 in 2001. During the post liberalisation period, the highest increase in the high productivity districts has taken place in the western region where their number increased from 12 in 1991 to 17 in 2001. The number of high productive districts increased from 5 in 1991 to 8 in 2001 in the eastern region, from 1 to 4 in the central region, and from 0 to 1 in the Bundelkhand region (table 4.3 and 4.4).

Table 4.4
Distribution of Districts in Different Regions by Levels of Productivity in 2001-02

Productivity Level (Rs./Hectare at 1990-93 prices)		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
High	8000 and above	1	4	8	17	30
Medium	5000-8000	1	5	7	2	15
Low	less than 5000	3	0	0	0	3
overall		5	9	15	19	48

Source: Department of Agricultural Statistics, Uttar Pradesh

To sum up, the agricultural economy of UP seems to have recorded quite a significant progress since 1980-81. This is brought out by the fact that whereas the number, the area and the contribution to output of high productivity districts has recorded a significant increase over the period 1980-81 to 2001-02, that of low productivity districts has declined perceptibly and that of medium productivity districts has remained almost constant.

4.3 Productivity Levels and Use Of Inputs

The previous section was devoted to a discussion of the differences in the levels of land productivity at the district level during the period 1981, 1991 and 2001. The differences in productivity per hectare among districts can be a) either due to differences in the quantity of output produced per hectare of a crop, i.e. due to differences in physical yield, (b) and/or due to differences in the cropping pattern. Thus, it is possible for a district to have a higher level of value productivity than another district, even when it has lower physical yield in most of the crops, provided its share of area under high value crops is much higher. To a great extent, cropping pattern gets determined by physical conditions of productions like soil type, pattern of rainfall, topography and elevation from sea level etc., but within the set of crops that can be grown in a region, crop combinations get determined by relative yield levels and prices. Thus, along with relative prices, the new technology can also help change the cropping pattern[1].

However, it is significant to note that the yield levels can be raised more easily through provision of necessary infrastructural facilities than by changing the cropping pattern. The present section would be devoted to a discussion of the relationship between the yield level and use of various inputs like irrigation, fertiliser use, number of agricultural workers per 1000 hectare, rain fall etc. at district level.

There exists a high degree of association between the level of agricultural productivity and the use of various inputs. For the state as whole, average productivity per hectare of all crops taken together rose from Rs.6752.02 in 1980-81 to Rs.10074.91 in 2001-02. Simultaneously, the share of gross irrigated area to total cropped area rose from 46.3 percent to 70.7 percent between the two years. During the same period, the use of

[1] Leena .D,(1998)

fertilisers per hectare rose from 47.4 kg to 129.8 kg per hectare and the number of male agricultural workers per 1000 hectare rose from 930 in 1991 to 2129 in 2001.

Table 4.5

Distribution of Districts and Input Use by Productivity Levels in 1981, 1991, and 2001

Productivity Level		No of districts			Fertiliser Consumption (Kgs/Hect)			Fertiliser Consumption (Kgs/Hect)		
(Rs./Hectare at 1990-93 prices)		1981	1991	2001	1981	1991	2001	1981	1991	2001
High	8000 and above	7	18	30	72.2	123.3	149.3	68.6	77.8	77.8
Medium	5000-8000	19	22	15	57.1	82.8	111.0	48.9	64.6	67.9
Low	less than 5000	22	8	3	34.3	39.4	35.1	39.3	37.3	41.4
overall		48	48	48	47.4	88.7	129.8	46.3	62.3	70.7

Source: Department of Agricultural Statistics, Uttar Pradesh

The very large concentration in the use of modern inputs in the high productivity districts is brought out in table 4.5. For example, during 1981, compared with an average fertiliser consumption of 47.4 kg per hectare, the high productivity districts were consuming 72.2 kg per hectare. During 2001 compared with an average of 129.8 kg per

Table 4.5b

TOTAL RAINFALL

Productivity Level (Rs./Hectare)	Rainfall in kharif season				Rainfall in Rabi Season			No of Male Agri Workers /1000Hc		
(1990-93 prices)		1981	1991	2001	1981	1991	2001	1981	1991	2001
High	8000 and above	732.0	745.9	819.51	82.57	46.64	69.85	911.33	1076.02	1433.11
Medium	5000-8000	1185	661.3	821.36	39.31	26.68	65.19	952.50	1091.10	1593.47
Low	less than 5000	1348.9	794	805.5	29.97	23.02	55.23	918.15	898.39	1109.07
Overall		1194.1	715.1	819.213	41.34	33.56	67.48	930.13	1055.89	1382.52

Source: Department of Agricultural Statistics, Uttar Pradesh

hectare, the high productivity districts were using 149.3 kg of fertilisers per hectare. Similar picture emerges with respect to the percentage of gross irrigated area. Again during 2001, compared to the state average of 70.7 percent of gross irrigated area, as much as 77.8 percent of GCA was irrigated in the high productive districts.

At the other extreme, the use of fertilisers and proportion of irrigated area were very low in the low productivity districts. In 1981, low productivity districts consumed only 34.3 kg fertiliser per hectare compared with 72.2 kg in high productive districts. By 2001, as compared with high productivity districts, low productivity districts had less area under irrigation. Thus, the share of low productivity districts in the fertiliser and irrigation was low. During 1981, with 46 percent of the gross irrigated area, low productivity districts accounted for 22.92 percent of the total value of output in the state. Their share in the use of inputs was relatively low as is shown in table 4.5.

During the period 1981 to 2001 the number of agricultural workers has increased by almost 50 percent for the high and the medium productivity districts (table4.5B). However, the number of workers have not increased in the same proportion for the low productivity districts. Since infrastructural facilities are not well developed in Uttar Pradesh, number of workers is an important variable in explaining the changing productivity in agriculture.

To sum up, the tables try to bring out the positive association between productivity levels and use of inputs like fertilisers use, proportion of area under irrigation and the number of agricultural workers.

The previous sections were devoted to the spatial variation at the district level in the levels of agricultural output and changes therein over the period 1980-81 to 2001-02. This section examines the nature and pattern of output and productivity growth at the district level during the period 1980-81 to 2001-02.

The 48 districts were divided into 3 categories on the basis of rates of growth[2] of value of output.

1. High growth districts – those with annual growth rate exceeding 3.5 percent.

[2] Growth Rate are Compound Annual growth Rate

2. Medium growth districts – those with annual growth rates between 1.5 to 3.5 percent.

3. Low growth districts – those with annual growth rates less than 1.5 percent.

4.4 Disparities in Growth Rates

One of the main contributions of the new seed fertiliser technology was to increase the growth rates of crop output and raise the productivity level of districts that adopted the new technology. The spread of new technology gathered momentum during the eighties when the new technology spread to the eastern and the central region of Uttar Pradesh.

To begin with, the new technology was highly biased in favour of assured irrigated areas. Although over the years this bias has slightly diminished, nevertheless, irrigated areas were able to record much higher growth rates after the adoption of new technology. Consequently, during 1980-81 to 2001-02, UP agriculture was characterised not only by rapid transformation but also by wide variations in growth performance.

Table 4.6

District wise growth of Area, Output and Yield during 1980-81 to 2001-02

Growth of Output		No of districts			1980-81 to 1991-92			1991-92 to 2001-02			1980-81 to 2001-02		
(% P.A)		1991 / 1981	2001 / 1991	2001 / 1981	Output	Area	Yield	Output	Area	Yield	Output	Area	Yield
High	>=3.5	25	16	13	4.49	0.53	3.94	4.60	0.85	3.72	3.67	0.17	3.48
Medium	1.5-3.5	18	19	30	2.65	0.14	2.51	2.46	0.58	1.88	3.42	0.27	3.15
Low	<=1.5	5	13	5	-0.73	-0.46	-0.26	0.25	-0.19	0.45	1.41	0.22	1.19
Overall		48	48	48	3.82	0.29	3.49	2.4	0.51	1.83	3.04	0.40	2.63

Source: Department of Agricultural Statistics, Uttar Pradesh

During the period 1980-81 to 2001-02, the overall growth rate of aggregate output was 3.04 percent per annum. Whereas 13 districts in UP during 1981 to 2001 recorded

growth rates exceeding 3.5 percent per annum, as many as 30 districts recorded medium growth ranging between 1.5 to 3.5 percent per annum. The number of districts that recorded low growth, i.e. below 1.5 percent per annum, was 5 (Table 4.6).

For the period 1980-81 to 2001-02, growth of output at the state level as also for all growth categories, was associated with growth of land productivity is clear from the fact that the overall annual growth rate of 3.04 percent in output during this period was accompanied by productivity growth of 2.63 percent and area growth of only 0.40 percent par annum. Thus, nearly 86 percent of growth was because of yield increase (table 4.7).

Spatial Pattern

The details about the spatial distribution of districts according to their output growth rates during 1980-81 to 1991-92, 1991-92 to 2001-02 and 1980-81 to 2001-02 have been given in tables 4.7, 4.8 and 4.9 respectively. The tables bring out that over the period 1980-81 to 2001-02, there were 13 districts that recorded high growth rates, exceeding 3.5 percent. Whereas 5 districts of these belonged to the western region, 5 belonged to the eastern region and only 2 and 1 to the central and the eastern region, respectively.

Table 4.7

Contribution of Area and Yield to Output Growth During 1980-81 to 2001-02

Growth of Output		1980-81 to 1991-92		1991-92 to 2001-02		1980-81 to 2001-02	
(% P.A)		Area	Yield	Area	Yield	Area	Yield
High	>=3.5	11.76	87.80	18.48	80.87	4.63	94.82
Medium	1.5-3.5	5.25	94.66	23.57	76.42	7.89	92.11
Low	<=1.5	63.45	35.54	-76.00	180.00	15.60	84.40
overall		7.59	91.36	21.25	76.25	13.16	86.51

Source: Department of Agricultural Statistics, Uttar Pradesh

Table 4.8

Distribution of Districts in Different Regions by Growth Rate of Output

1980-81 to 2001-02						
Growth of Output		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
(% P.A)						
High	>=3.5	1	2	5	5	13
Medium	1.5-3.5	2	6	10	12	30
Low	<=1.5	2	1	0	2	5
overall		5	9	15	19	48

Source: Department of Agricultural Statistics, Uttar Pradesh

There were 30 medium growth districts that recorded an annual growth rate between 1.5 to 3.5 percent. Out of these, 12 belonged to the western region, 10 to the eastern region, six districts belonged to the central region and two belonged to the Bundelkhand region.

Finally, the five low growth districts that recorded the growth rates less than 1.5 percent per annum belonged to the western region (2 districts), the Bundelkhand region (2 districts) and the central region (1 district).

Table 4.9

Distribution of Districts in Different Regions by Growth Rate of Output

1980-81 to 1991-92						
Growth of Output		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
(% P.A)						
High	>=3.5	1	4	10	10	25
Medium	1.5-3.5	1	4	5	8	18
Low	<=1.5	3	1	0	1	5
overall		5	9	15	19	48

Source: Department of Agricultural Statistics, Uttar Pradesh

4.5 Growth During 1980-81 to 1991-92

For a comparative analysis, it is useful to sub-divide the entire period 1980-81 to 2001-02 into two sub-periods, namely the periods between 1980-81 to 1991-92 and 1991-92 to 2001-02.

There was a high rate of growth of 3.82 percent in agricultural output during the period 1980-81 to 1991-92. High growth rates were mainly due to intensification of new technology and its spread to more areas in the eastern and the central region. In addition to yield of major crops, because of adoption of new technology the second important source of growth was crop diversification from low yield and low value coarse cereals to higher value crops.

During the period 1980-81 to 2001-02, the predominant source of growth was yield growth, the contribution of area growth being only 7.5 percent. There were 25 districts which recorded a growth rate exceeding 3.5 percent. Most of the high growth districts were concentrated in the eastern and the western region. For example, 10 districts each of the western and the eastern region belonged to this set. Other regions that contributed to this category was the central region (4) and the Bundelkhand region (1).

There were as many as 18 districts that grew at a moderate rate 1.5 to 3.5 percent per annum. Finally, few districts continued to stagnate in terms of growth and as many as five districts had a growth rate less than 1.5 percent per annum during the period 1980-81 to 1991-92.

The high growth districts recorded the growth rate of 3.94 percent per annum in the yield levels, thereby increasing their yield from an average of Rs.10775.52 to Rs.16480.85 per hectare during the period 1980-81 to 1991-92. The medium growth districts were also able to record the growth rate of 2.51 percent per annum in their yields, thereby increasing their yield from an average of Rs.5999/hec to Rs.7878/hect. during this period. However, the 5 low growth districts recorded a perceptible decline in their share of both area and output over this period.

The medium growth districts were distributed all over UP with a major concentration in the western and the eastern region. Out of 18 districts that recorded

medium growth rates, 8 belonged to the western region, 5 to the eastern region, 4 to the central region and 1 to the Bundelkhand region.

The slow growth districts were mainly located in the Bundelkhand region. Out of the 5 low growth districts, 3 belonged to the bundelkhand region, 1 to the central region and 1 to the western region.

4.6 Growth During 1991-92 to 2001-02

The post liberalisation period is characterised by the decline in growth rates. During this period, 16 districts recorded growth rates exceeding 3.5 percent per annum as compared with 25 districts with rates exceeding 3.5 % per annum during 1980-81 to 1991-92 (table 4.6).

During the decade 1991-92 to 2001-02, there was an increase in the number of districts that recorded medium growth ranging 1.5 to 3.5 percent per annum. Thus, there were 19 districts that recorded medium growth during the latter period, as compared with 18 districts during the period 1980-81 to 1991-92.

Finally, during the post liberalisation period, the number of districts with growth rates less than 1.5% per annum has increased to 13.However, during 1980-81 to 1991-92, there were five low growth districts.

4.7 Spatial Distribution

The spatial distribution of districts by their growth rate has undergone a distinct change during 1991-92 to 2001-02, with many high productivity districts in the western region, the central region and the eastern region recording medium and low rates of growth and many low productivity districts in the Bundelkhand region recording increases in their growth rates.

Table 4.9 and 4.10 that give spatial distribution of districts according to their growth rates during period 1991-92 to 2001-02 provide interesting results. Out of the 16 high growth districts where growth exceeded 3.5 percent per annum, as many as 6 were located in the western region followed by 4 each in the eastern and the Bundelkhand region and 2 in the central region. The most remarkable feature of such a development

pattern has been the low productivity areas in the Bundelkhand region recording the highest growth rate during the recent period.

Table 4.10

Distribution of Districts in Different Regions by Growth Rate of Output

1991-92 to 2001-02						
Growth of Output		Bundelkhand	Central	Eastern	Western	Uttar Pradesh
(% P.A)						
High	>=3.5	4	2	4	6	16
Medium	1.5-3.5	0	5	6	8	19
Low	<=1.5	1	2	5	5	13
overall		5	9	15	19	48

During 1991-92 to 2001-2002, the 19 medium growth districts were concentrated in the western, the eastern and the central region. Many districts in the western region, central region and the eastern region slipped down from high growth category to the medium growth category.

Among the 13 low growth districts, districts each were located in the western and the eastern region, and 2 in the central region and one in the Bundelkhand region.

Table 4.11

Distribution of Districts by Growth of Output During 1980-81 to 1991-92 and Growth in Area, Yield and Inputs Used

Growth of Output		No of districts	Yield	Yield	Percent Annual Growth Rate of					
(% P.A)			1980-81	1991-92	Output	Area	Yield	Irrigation	Fertiliser	MAW
High	>=3.5	25.0	10775.5	16480.8	4.5	0.5	3.9	3.3	6.2	1.4
Medium	1.5-3.5	18.0	5999.0	7878.7	2.7	0.1	2.5	2.4	5.1	1.5
Low	<=1.5	5.0	3845.9	3733.8	-0.7	-0.5	-0.3	3.2	6.5	1.5
Overall		48.0	8299.9	12146.3	3.8	0.3	3.5	2.7	5.9	1.5

Table 4.12

Distribution of Districts by Growth of Output During 1991-92 to 2001-02 and Growth in Area, Yield and Inputs Used

Growth of Output		No of districts	Yield	Yield	Percent Annual Growth Rate of					
(% P.A)			1991-92	2001-02	Output	Area	Yield	Irrigation	Fertiliser	MAW
High	>=3.5	16.0	5778.3	8324.8	4.6	0.9	3.7	1.2	5.0	2.9
Medium	1.5-3.5	19.0	19466.9	23441.2	2.5	0.6	1.9	1.0	3.5	3.6
Low	<=1.5	13.0	10397.8	10870.2	0.3	-0.2	0.5	1.0	3.0	3.7
overall		48.0	12146.3	14665.7	2.4	0.5	1.8	1.3	3.9	3.4

One also sees an association between the growth rate of output and use of inputs like fertiliser and area under irrigation for UP as a whole and in various regions of UP, although in this case there is no clear association.

4.8 Determinants of Agricultural Productivity: A Cross Sectional-Time Series Analysis of Uttar Pradesh

Agriculture is a complex and multi-dimensional sector. Its development depends on various factors like agro-climatic conditions, technology, inputs, systems of land holdings and other socio-economic factors. There are host of factors, which determine agricultural productivity. The most typical feature about agriculture is that, contribution of factors to the increment of agricultural output is region specific. For example, Chemical fertilisers may be very effective in increasing output level of the plain lands, whereas its application may not significantly increase output level in the hilly region. Secondly, the modern day agricultural inputs are in a kind of package application. To be precise, high yield variety requires high fertiliser use and fertiliser application requires well-irrigated and well drainage system of lands. Thus, it is very difficult to study in isolation the factors, which affect the agricultural productivity the most in Uttar Pradesh, given the heterogeneity of agro-climatic conditions.

Despite all these limitation, an attempt has been made to study the agricultural productivity in Uttar Pradesh with respect to irrigated area, number of workers per hectare, fertiliser use and rain fall.

This study has taken up with the following specific objective: To examine which of the factors (proportion of area irrigated, fertiliser consumption per hectare, number of workers per hectare, average rainfall in the kharif and rabi season) have greater importance in explaining land productivity in UP agriculture.

Model Specification

In most of empirical study on agricultural productivity, the Cobb-Douglas production function has been extensively employed to measure the nature and contribution of individual factors to output. When variables are entered in logarithmic form estimated coefficients are interpreted as elasticities, all estimated coefficients provide information about the nature of returns to scale, intercept term is interpreted as disembodied technical change and the marginal productivity of resources can be derived from the estimated coefficients.

In this study also Cobb-Douglas kind of production function has been used.

The function is as follows:

$$Y_{it} = \beta_1 L_{it}^{\beta_2} I_{it}^{\beta_3} Rr_{it}^{\beta_4} F_{it}^{\beta_5} Rk_{it}^{\beta_6} \quad \text{----------(1)}$$

Where Y is the per hectare agricultural output at 90-93 constant prices, L is the number of agricultural workers per hectare, I is the proportion of area irrigated (irrigated area/hectare), F is the fertiliser consumption per hectare (Kgs/ha), Rk is the rainfall in the Kharif season and Rr is the rainfall in the Rabi season.

Due to high correlation between irrigated area and fertiliser consumption per hectare, the duo has been taken separately in two different equations. Thus, the two equations are as follows:

$$Y_{it} = \beta_1 L_{it}^{\beta_2} I_{it}^{\beta_3} Rr_{it}^{\beta_4} Rk_{it}^{\beta_6} \quad \text{----------(2)}$$

$$Y_{it} = \beta_1 L_{it}^{\beta_2} Rr_{it}^{\beta 4} F_{it}^{\beta_5} Rk_{it}^{\beta_6} \quad \text{----------(3)}$$

Taking log the equation 2 and 3 can be expressed as:

$$Log(Y_{it}) = \beta_1 + B_2 Log(L_{it}) + \beta_3 Log(I_{it}) + \beta_4 Log(Rr_{it}) + \beta_6 Log(Rk_{it}) + U_{it}$$

---------(Eqn. 2*)

$$Log(Y_{it}) = \beta_1 + B_2 Log(L_{it}) + \beta 4 Log(Rr_{it}) + \beta_5 Log(F_{it}) + \beta_6 Log(Rk_{it}) + U_{it}$$

---------(Eqn. 3*)

Panel estimation using GSL:

The basic equation from which the model is developed is given by:

$Y_{it} = x_{it} + \mu_{it}$ Where I=1..m is the no. of units (or panels) and t=1...n is the no. of observations for panel i. In case of Ordinary least squares, the coefficients has been estimated by:

$$\hat{\beta} \text{ (old)} = (x'x)^{-1}x'y$$

Determinants of Agricultural Productivity (Land Productivity)

In this study 4 major inputs have been taken as the determinants of Agricultural productivity. They are as follows (a) Agricultural workers per hectare (b) Irrigated Area (c) Fertiliser Consumption and (d) Rainfall. Though, there are many other important variables which could explain the Agricultural productivity in a significant manner due to paucity of data, this study is limited with the above mentioned factors.

Agricultural workers: There is not any systematic availability of district wise agricultural workers data in time series for UP. In the "census of India report", it is given at a point of time at a decadal interval. So worker data has been interpolated for the rest of the years. Here, our analysis have taken total number of agricultural workers per hectare as the worker input.

Irrigated Area: To get proportion of area irrigated, the total irrigated area of the districts has been divided by the gross cropped area of the districts.

Fertiliser Consumption: Fertiliser consumption is one of the important variables of this study. We have taken the sum of Chemical fertiliser such as nitrogen (N), Phosphorus (P_2O_5) and Potash (K_2O) as the total fertiliser consumption in agricultural sector.

Rainfall: UP agriculture depends upon southwest monsoon, as the irrigation facilities are inadequate. We have taken the rainfall data for in the Kharif and Rabi season. During the Kharif crop, adequate rainfall is required; otherwise production level will go down. But, the Rabi crops as such do not require much rainfall. .

4.9 Result (Panel Evidence of Agriculture Productivity i.e. Land Productivity In UP 1980-81 to 2001-02).

From the table 4.13 and 4.14 it is evident that output per hectare is the dependent variable. Proportion of area irrigated, fertiliser consumption per hectare, number of workers per hectare, average rainfall in the kharif and rabi season are the independent variable.

The results of the estimation of Cobb-Douglas production function for all the 48 districts for the period 1980-81 to 2001-02 is summarized in table 4.13 and 4.14. All the included variables show expected behavior as the estimated value of coefficient bear expected positive signs. The only exception is the coefficient for rainfall in the Rabi season. The variable has negative sign with insignificant coefficient. But, this is not surprising because the Rabi crops do not require much rainfall. The underlying hypothesis in this production relationship is that the increased use of Proportion of area irrigated, fertiliser consumption per hectare, number of workers per hectare, timely and adequate rainfall during the kharif and rabi season in UP agriculture leads to increased agricultural productivity.

The worker co-efficient i.e. the elasticity of workers per hectare input with respect to output per hectare is 0.204. This says that, if the worker input will increase by 1 percent.

Table 4.13

Panel Data Analysis

Random-effects GLS regression	Number of obs = 1056
Group variable (i): district	Number of groups = 48
R-sq: within = 0.6469	Obs per group: min = 22
between = 0.1402	avg = 22.0
Overall = 0.1951	max = 22
Random effects u_i ~ Gaussian	Wald chi2 (4) = 1836.22
Corr (u_i, X) = 0 (assumed)	Prob > chi2 = 0.0000

panel variable: district, 1 to 48 time variable: time, 1 to 22

Yield |	Co ef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
~~Irr_ar~~	.204	.0187	6.30	0.000	.0814365	.1550267
~~Worker per hect~~	.435	.039	3.95	0.000	.0796475	.2362774
rn_kh	.056	.013	4.18	0.000	.0297719	.0824382
rn_rbi	- .0041	.0107	-.380	0.704	-.0252413	.0170404
Cons	11.518	.103	111.21	0.000	11.31577	11.72179

Note: Worker per hect = Worker per hectare, irr_ar = percentage irrigated area, Fer= Fertiliser consumption per hectare, rn_kh = rainfall in kharif season, rn_rbi = rainfall in Rabi season

Table 4.14

Random-effects GLS regression	Number of obs = 1056
Group variable (i): district	Number of groups = 48
R-sq: within = 0.6546	Obs per group: min = 22
Between = 0.1580	avg = 22.0
Overall = 0.2114	max = 22
Random effects u_i ~ Gaussian	Wald chi2 (4) = 1894.81
Corr (u_i, X) = 0 (assumed)	Prob > chi2 = 0.0000

Panel variable: district, 1 to 48 Time variable: time, 1 to 22

Yield |	Co ef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Irr_ar	.301	.0174	24.44	0.000	.391682	. 4599876
Worker per hect	.204	.0187	6.30	0.000	.0814365	.1550267
rn_kh	.052	.0133	3.92	0.000	.0261358	.0782909
rn_rbi	-.0024	.0109	-0.225	0.822	-0.024014	.0190783
Cons	10.93	.1383	79.05	0.000	10.66513	1.20747

the output will go up by 0.20 percent. From the table, it is clear that; worker is an important variable with higher co-efficient value. The co-efficient is also significant at 1 percent level. As explained earlier worker per hectare is one of the few important variables which could explain the changing productivity in agriculture in a significant manner.

The co-efficient of proportion of area irrigated is 0.31. The co-efficient shows the elasticity of proportion of area irrigated with respect of output per hectare. If there will be 1 percentage increase in irrigated area per hectare output will go up by 0.31 percent. The value of the co-efficient is low in comparison to other variable like fertiliser. This says that, though irrigation facilities affect positively to the production level but in comparison to fertiliser, its contribution is less. This is because a quarter of the net sown area of UP is without irrigation.

The co-efficient of rainfall during the Kharif season is 0.05. It has been discussed that irrigation facilities in UP is not well developed. The eastern region has comparatively less irrigated areas but it has very high land productivity. Rainfall plays an important role in the rice cultivation in the eastern region. The Kharif crops require high temperature and plentiful supply of water. Thus, we have earlier hypothesized that adequate and timely rainfall has positive impact on agricultural productivity. Also, it is found that the co-efficient of Kharif rainfall is positive i.e. 0.05 and it is significant at 1 percent level.

The co-efficient of rainfall in the rabi season is negative and insignificant. The co-efficient is insignificant because the rainfall in the rabi season does not have any impact on the productivity level of agriculture.

The co-efficient of fertiliser consumption per hectare is 0.435. This is the value of input elasticity with respect to per hectare output. This says that if fertiliser

consumption per hectare goes up by 1 percent, the per hectare output level will go up by 0.435 percent. In our regional and district level analysis, it has been found that fertiliser consumption and yield has increased at a higher rate during the period 1980-81 to 2001-02.

As explained earlier, due to multicollinearity problem our study could not take fertiliser consumption and irrigated area in the same equation.

The model is highly significant as the Wald Chi-square is significant at 1 percent level. From the above analysis, one can conclude that in UP (taking 48 districts and 22 years) agricultural productivity is highly influenced by fertiliser consumption per hectare, followed by irrigation, agricultural worker per hectare, and rainfall.

4.10 Conclusion

The district level analysis undertaken in this chapter on the nature and pattern of inter-district variation in yield levels during 1980-81 to 2001-02 confirm many of the result at the region level.

To begin with during 1981, the yield levels in most of the district in UP were low. As many as 22 districts out of 48 districts, accounting for 46.8 percent of area and 22.9 percent of output of 24 crops had low productivity level. During 1981 to 2001, there was a significant increase in yield levels in almost all the districts across all the four regions in Uttar Pradesh. The result was that by 2001, where as area under high yield districts increased from 15.29 percent during 1981 to 66 percent during 2001, that under medium districts decreased from 37.9 to 27.78 percent during the same period. On the other hand, during the mean time the weightage in terms of share of area of low yield districts had declined from 46.8 to 6.12 percent. This highlights the dimension of change during 1981 to 2001.

The spatial distribution of districts according to yield levels also underwent a big change. While during 1981, all regions were characterised by low to medium yield levels and high yield districts were confined only to the western region. By 2001, yield level increased across almost all the regions of UP because of the extension of new technology to new areas and its consolidation over time. Yield level recorded a notable increase in districts belonging to the central and the eastern region in addition to the western region.

On the other hand, most of the districts in the Bundelkhand regions, which belonged to the low productivity category during 1981, graduated to higher levels of yields.

The success of new technology in raising the yields is very much related with the inputs like irrigation, fertiliser use, number of agricultural workers etc. There is very high association between these inputs and levels of yield across districts.

The growth of agricultural output was much more widespread across all the regions of UP during 1981 to 2001. The spatial distribution of districts according to their growth rates over various periods highlights the tremendous improvement in regional coverage of growth over the period 1981 to 2001.

CHAPTER V

Summary Results and Conclusion

The introduction of yield raising new seed-fertiliser technology during the mid sixties led to a marked increase in the growth rate of agricultural output in UP and has been instrumental in the gradual process of transformation of traditional household agriculture into modern, scientific agriculture in different parts of UP. Because of differences in agro climatic conditions and in resource endowments, UP agriculture has been characterised by wide inter regional inequalities. The differential adoption of the new seed fertiliser technology in various parts of UP has resulted not only in bringing about significant changes in the regional patterns of levels and growth of agricultural output, but also in perpetuating the existing regional inequalities.

The present study is undertaken to examine the growth and pattern of agricultural productivity during the pre and post liberalisation period[3]. The first part of our analysis focuses on the growth and pattern of agriculture productivity for the state and the regions. The variables such as area irrigated, fertiliser consumption, agricultural workers and rainfall is taken to explain the agricultural productivity in the state. The second part of our analysis is on the cropping pattern changes for regions and the state as a whole. The third part analysis shows the growth of agricultural worker productivity. These above sections are included in Chapter-3. The last chapter studies inter-regional variation in productivity and changes over time at disaggregated district level.

The study finds that during the period 1950-51 to 2001-02, food grain production increased at a rate of 2.98 percent. The growth in the western region was highest followed by the eastern region, the central region and the Bundelkhand region. In terms of food-grain productivity growth, the performance of western region was the best during 1950-51 to 2001-02. The performance in terms of the two major food grains has shown different developments. While productivity increases in wheat have been the highest in the western region during the period 1950-51 to 2001-02, production has grown at a significantly higher rate in the eastern and the central region. In case of rice, the western

[3] However, our analysis for food grains, wheat and rice has been conducted for a long period viz. 1950-51 to 2001-02.

region led in terms of both production and productivity growth during the period 1950-51 to 2001-02.

The study for different sub-periods shows that in the sixties the food grain production grew at the rate of 2.69 percent per annum. During this period, the growth in the western region was the highest, fallowed by the eastern region. Compared to the decade of the 1960s, all the regions of the state have shown lower growth of food grain production in the following decade. In terms of food grain productivity growth, the performance of western region was the best during the 1960s and 1970s.

UP as a whole registered a growth rate in food grain production of 4.5 percent during 1980-81 to 1991-92. The eastern region, because of high productivity growth and increase in area, registered the highest rate of growth during the 80s followed by the central and the western region. However, the trend growth rate in food grain production in the subsequent decade (1991-92 to 2001-02) declined. (Highest growth rate in the Bundelkhand region followed by the eastern, western and the central region).

During the period 1980-81 to 1991-92, trend growth rate in food grain productivity in the eastern region has been the highest. In the pre-liberalisation period, food grain productivity growth in the eastern region was 4.03 percent compared to 3.71 percent in the central region and 3.49 percent in the western region. In the post liberalisation period, food grain productivity growth has declined for all the regions. The Bundelkhand region was the only exception where food grain productivity growth has increased.

The performance in terms of the two major food grains has shown different developments. While productivity increases in wheat have been the highest in the central region during the period 1980-81 to 1991-92, production has grown at a significantly higher rate in the eastern region, led by higher area increases. In the post liberalisation period the trend growth rate of area, production and yield for wheat have declined for all the regions except the Bundelkhand region.

In case of rice, the eastern region led in terms of both production and productivity growth during the period 1980-81 to 1991-92. In the post liberalisation period the Bundelkhand region has recorded the highest growth in production and productivity for both wheat and rice.

The study on total cereals reveals that during the period 1980-81 to 2001-02, production increased at a rate of 2.98 percent. The trend growth rate in the eastern region was the highest followed by the central, western and the Bundelkhand region. The state as a whole registered a growth rate of 3.8 percent in cereals production during 1980-81 to 1991-92. The eastern region recorded the highest rate of growth during the 80s, followed by the central, western and the Bundelkhand region. Nevertheless, the trend growth rate in a cereals production in the subsequent decade (1992-93 to 2001-02) declined. (Highest growth rate in the Bundelkhand region, followed by the eastern region).

In terms of total cereals productivity growth, the performance of eastern region was the best during 1980-81 to 1991-92. Nevertheless, in the post liberalisation period, the Bundelkhand region recorded the highest growth in cereals productivity.

During the period 1980-81 to 2001-02, pulse production declined at a rate of 0.45 percent. The decline in the western region was the highest, followed by central region and eastern region. However, the Bundelkhand region recorded the trend growth of 3.38 percent.

The state as a whole registered a growth rate in pulse production of 0.65 percent during 1980-81 to 1991-92. The Bundelkhand region, because of increase in area, registered the highest growth during the pre liberalisation period followed by the eastern region. The trend growth rate has declined in the central and the western region in the preliberalisation period. In the post liberalisation period, pulse production in the Bundelkhand region, the central region, the eastern region and UP as whole witnessed fluctuations in growth over time. However, the western region, because of productivity growth and increase in area, registered the trend growth of 2.87 percent during the period 1992-93 to 2001-02.

The study on total oilseeds production shows that during the period 1980-81 to 2001-02, the state as whole registered a growth rate of 4.08 percent. The growth in the Bundelkhand region was the highest, followed by eastern, central and western regions. In the pre liberalisation period, the growth rate was much impressive in comparison to the post liberalisation period for UP as a whole. It registered a growth rate of 7.74 percent

and -3.08 percent respectively. In both the decades, Bundelkhand registered the highest growth rate.

The total oilseeds productivity growth shows that, the performance of the Bundelkhand region was the best during 1980-81 to 2001-02. In the pre liberalisation period, the Bundelkhand region registered the highest growth rate. On the other hand, western region registered the highest growth in the post liberalisation period.

Potato production shows that during the whole period, the growth in the western region was the highest, followed by the central, eastern and the Bundelkhand region. The eastern region, mainly because of increase in area, registered the highest production growth during the preliberalisation period, followed by the western and the central region. The trend growth rate in the subsequent decade declined with the western region recording the highest growth, followed by central and eastern regions.

In sugarcane production, the central region has topped the list followed by Bundelkhand, western and eastern regions during the period 1980-81 to 2001-02. The state as a whole registered a growth rate of 3.76 percent during the pre liberalisation period. The central region, because of increase in area, registered the highest rate of growth during the 1980s, followed by the western region and the eastern region. The trend growth rate in sugarcane production in the subsequent decade (1991-92 to 2001-02) declined (Highest in the Bundelkhand region followed by central region). In terms of sugarcane productivity growth, the performance of the central region was the best during the period 1980-81 to 2001-02.

Another important development during this period was that the cropping pattern has not changed much, although there has been little shift from coarse cereals towards wheat and rice. Inter temporal comparison shows that the percentage of area under food crops, has declined in almost all the regions during 1980-81 to 2001-02. In all the regions, there has been a shift towards non-food commercial crops over time. However, the shift towards commercial crops has not been much. In the Bundelkhand region, there has been a shift towards high value crops, mainly pulses. Gini co-efficient and entropy indices show that the Bundelkhand region has relatively diversified cropping pattern.

However, the regions like central, eastern and western have cropping pattern concentrated around a few crops.

The values of co-efficient of localisation have increased for wheat, arhar, bajra, maize, potato, tobacco etc. The increase in the value of co-efficient of localisation implies that over the period, the concentration of these crops has increased across districts. For crops such as rice, groundnut, gram, pea, sugarcane, til, urad etc, the co-efficient of localisation has decreased. This implies that the spread of rice, groundnut, gram, pea, sugar cane, til, urad have increased over the period.

Another important finding is that during 1980-81 to 1991-92, there is a marked rise in agricultural worker productivity in crop sector across all the regions. However, in the post liberalisation period, the eastern region, central region and the state as a whole had a negative growth in workers' productivity. In the post liberalisation period, there was a decline in the growth of agricultural output in all the regions but number of agricultural workers increased at a faster rate.

During the period 1980-81 to 1991-92, twenty-five districts recorded a growth rate exceeding 3.5 percent. Most of the high growth districts were concentrated in the eastern and the western region. As many as 18 districts grew at a moderate rate while five districts had a growth rate less than 1.5 percent per annum during the period 1980-81 to 1991-92.

The medium growth districts were distributed all over UP with a major concentration in the western and the eastern region. Out of 18 districts that recorded medium growth rates, eight belonged to the western region, five to the eastern region, four to the central region and one to the Bundelkhand region. The slow growing districts were mainly located in the Bundelkhand region. The post liberalisation period is characterised by the decline in growth rates. During this period, 16 districts recorded growth rates exceeding 3.5 percent per annum as compared to 25 districts during 1980-81 to 1991-92.

During the decade 1991-92 to 2001-02, there was an increase in the number of districts that recorded medium growth. Finally, during the post liberalisation period, the

number of districts with growth rates less than 1.5% per annum has increased to 13. However, during 1980-81 to 1991-92, there were five low growth districts.

The spatial distribution of districts by their growth rate has undergone a distinct change during 1991-92 to 2001-02 with many high productivity districts in the western region, the central region and the eastern region recording medium and low rates of growth and many low productivity districts in the Bundelkhand region recording acceleration in their growth rates. Many districts in the western region, central region and the eastern region slipped down from high growth category to medium growth category.

The inference of the study is that the growth of agricultural output was much more widespread across all the regions of UP during 1981 to 2001. The spatial distribution of districts according to their growth rates over various periods highlights the tremendous improvement in regional coverage of growth over the period 1981 to 2001.

However, there is no clear association between the growth rate of output and use of inputs like fertiliser and area under irrigation for UP as a whole as well as for various regions of UP.

From the cross-sectional time series analysis one can conclude that in UP (taking 48 districts and 22 years) agricultural productivity is highly influenced by fertiliser consumption per hectare, followed by irrigation, agricultural worker per hectare and rainfall.

To conclude, the new technology spread to the eastern and the central region of UP during the period 1980-81 to 1991-92. The crop output recorded an unprecedented growth rate during 1980-81 to 1991-92. The agricultural growth rates in the eastern and the central region were comparatively higher than the western region. There was a decline in the crop output growth in the post liberalisation period for all the regions. In the 90s, the central and the eastern region maintained the higher agricultural growth vis a vis the western region. The slower growth of productivity in the western region can be attributed to much higher growth in the earlier decades. At the same time, the eastern and the central region had a faster growth in agricultural production due to better and enhanced utilisation of new technology.

The Bundelkhand region has done reasonably well vis-à-vis other regions in the post liberalisation period. It might be because the Bundelkhand was the most backward region during the 80s. Though its output growth has increased in the 90s, still the productivity level in the Bundelkhand region is comparatively low vis a vis other regions of UP.

APPENDIX

Percentage Share of Agriculture in GSDP

Table 1

Year	% Share of Agr in GSDP (At 1993-94 Constant Price)
1980-81	47.86
1981-82	47.50
1982-83	46.14
1983-84	46.30
1984-85	45.59
1985-86	44.30
1986-87	43.45
1987-88	42.28
1988-89	41.41
1989-90	39.57
1990-91	39.98
1991-92	40.57
1992-93	39.19
1993-94	37.94
1994-95	37.10
1995-96	36.45
1996-97	35.90
1997-98	33.88
1998-99	33.17
1999-00	34.27
2000-01	33.57
2001-02	32.96
2002-03	30.28

Table 2

Total value of agricultural out put (In Rs lakhs)

	1980-81	1991-92	2001-02
AGRA	17167.6	16384.8	33457.8
ALIGARH	28766.3	36421.0	54734.7
ALLAHABAD	35292.8	44927.1	54373.7
AZAMGARH	32396.7	56614.6	63111.0
BAHRAICH	16975.5	30457.8	49552.1
BALLIA	16941.9	23646.3	27559.1
BANDA	21956.1	18791.1	29487.6
BARABANKI	22209.6	34003.2	38250.1
BAREILLY	27625.5	44537.3	58816.9
BASTI	32411.9	50266.8	74295.2
BIJNOR	46952.2	77165.4	91161.9
BUDAUN	27928.4	38154.2	54881.0
BULANDSHAHAR	41044.0	50131.2	64526.5
DEORIA	41841.2	75472.4	70637.5
ETAH	21637.6	32529.0	50803.8
ETAWAH	20906.2	30526.6	38533.5
FAIZABAD	24007.0	39153.6	53721.9
FARRUKHABAD	29443.5	43033.0	65623.6
FATEHPUR	20584.4	25669.7	33167.6
GHAZIABAD	26844.8	32670.4	34448.9
GHAZIPUR	18332.5	32231.6	32835.6
GONDA	29585.4	42307.8	71930.6
GORAKHPUR	34427.3	61073.2	64821.3
HAMIRPUR	19700.0	16459.1	23907.5
HARDOI	27116.4	40329.9	51008.8
JALAUN	13478.2	13276.4	24221.0
JAUNPUR	25093.1	35660.5	38882.6
JHANSI	9796.5	12670.4	22113.8
KANPUR	30242.8	41274.6	49946.5
KHERI	34017.8	68458.9	101865.1
lalitpur	5682.5	9844.7	11013.1
LUCKNOW	10710.5	11659.6	13512.6
MAINPURI	21040.1	38380.1	53063.1
MATHURA	18535.6	23497.9	37033.7
MEERUT	58281.9	77514.3	85773.8
MIRZAPUR	17802.3	21131.4	36527.8
MORADABAD	56721.5	80382.9	92712.9
MUZAFFARNAGAR	63156.1	88758.3	95376.3
PILIBHIT	24646.8	41569.7	48587.0
PRATAPGARH	13392.8	21575.6	25207.0
RAEBARELI	16984.8	23072.9	31361.8
RAMPUR	19494.8	31354.9	38742.7
SAHARANPUR	51450.3	85390.9	57101.9
SHAJHANPUR	27030.5	52028.0	65138.3
SITAPUR	26609.9	43474.9	64912.1
SULTANPUR	17569.9	28780.4	37420.1
UNNAO	16930.2	22953.9	28670.3
VARANASI	683574.5	1072317.9	1387142.2

Table3
Output Per Acre

	1980-81	1991-92	2001-02
AGRA	3630.44	4442.58	7999.57
ALIGARH	4391.79	5801.41	8036.10
ALLAHABAD	5579.07	6751.10	7676.16
AZAMGARH	5092.82	7968.65	8875.90
BAHRAICH	2495.22	4373.73	6882.44
BALLIA	4783.71	6958.97	7963.33
BANDA	3721.58	3234.78	4772.31
BARABANKI	4958.56	7300.95	8491.02
BAREILLY	5767.10	9120.96	11134.85
BASTI	4058.88	5840.55	8925.87
BIJNOR	9955.10	17181.13	20381.03
BUDAUN	5030.14	6284.32	8071.87
BULANDSHAHAR	7200.63	8404.47	10077.83
DEORIA	6413.50	11424.26	10816.51
ETAH	4644.45	6554.93	9461.28
ETAWAH	5296.55	7024.35	8307.49
FAIZABAD	5290.99	8343.86	9606.74
FARRUKHABAD	7149.59	10408.37	14111.17
FATEHPUR	5212.77	6587.25	7936.38
GHAZIABAD	8673.01	10973.09	15133.87
GHAZIPUR	5015.63	8291.23	7914.76
GONDA	3808.66	5763.98	9195.26
GORAKHPUR	4750.14	8029.41	8652.26
HAMIRPUR	3738.11	3093.03	4004.38
HARDOI	4910.34	6980.96	7626.26
JALAUN	3675.47	3623.02	6208.90
JAUNPUR	5905.16	7891.03	8629.17
JHANSI	2858.90	3631.73	5342.41
KANPUR	5467.67	7182.60	8278.03
KHERI	5581.88	10614.58	14177.78
lalitpur	2479.79	3649.94	3224.51
LUCKNOW	5305.14	5759.06	6261.24
MAINPURI	5007.60	7149.46	8835.70
MATHURA	4225.94	5636.01	7673.63
MEERUT	11604.71	15695.50	17624.35
MIRZAPUR	3459.99	3965.71	6193.32
MORADABAD	8071.09	10871.37	11452.92
MUZAFFARNAGAR	12001.55	17778.12	19525.05
PILIBHIT	7135.65	11597.77	13414.59
PRATAPGARH	4480.59	6318.07	7308.57
RAEBARELI	4570.63	5565.39	7434.88
RAMPUR	6680.05	9925.05	10737.95
SAHARANPUR	8547.37	13962.75	13380.30
SHAJHANPUR	5527.12	9385.28	10775.24
SITAPUR	4868.51	7875.25	10331.60
SULTANPUR	4146.76	6673.57	8513.68
UNNAO	4391.68	5479.47	6294.74
VARANASI	146505.26	214560.57	280754.82

Table 4

Gross Cropped Area

	1980-81	1991-92	2001-02
AGRA	472881	368812	418245
ALIGARH	655003	627796	681110.75
ALLAHABAD	632593	665478	708345
AZAMGARH	636125	710466	711038
BAHRAICH	680320	696379	719979
BALLIA	354159	339796	346075
BANDA	589968	580909	617889
BARABANKI	447903	465737	450477
BAREILLY	479018	488296	528223
BASTI	798542	860651	832358
BIJNOR	471640	449129	447288
BUDAUN	555222	607133	679904
BULANDSHAHAR	570006	596483	640282
DEORIA	652392	660633	653053
ETAH	465880	496252	536965
ETAWAH	394714	434583	463841
FAIZABAD	453734	469250	559210
FARRUKHABAD	411821	413446	465047
FATEHPUR	394884	389687	417918
GHAZIABAD	309521	297732	227628
GHAZIPUR	365508	388743	414865
GONDA	776792	734003	782257
GORAKHPUR	724764	760618	749184
HAMIRPUR	527004	532134	597033
HARDOI	552232	577713	668857
JALAUN	366707	366447	390102
JAUNPUR	424936	451912	450595
JHANSI	342668	348881	413929
KANPUR	553120	574647	603362
KHERI	609432	644951	718484
lalitpur	229151	269723	341544
LUCKNOW	201890	202457	215813
MAINPURI	420163	536825	600553
MATHURA	438615	416925	482610.25
MEERUT	502226	493863	486678
MIRZAPUR	514518	532854	589794
MORADABAD	702774	739400	809513
MUZAFFARNAGAR	526233	499256	488482
PILIBHIT	345403	358428	362195
PRATAPGARH	298908	341491	344896
RAEBARELI	371607	414578	421819
RAMPUR	291836	315917	360802
SAHARANPUR	601943	611562	426761
SHAJHANPUR	489051	554357	604518
SITAPUR	546572	552045	628287
SULTANPUR	423703	431260	439529
UNNAO	385506	418908	455464
VARANASI	466587	499774	494076

Table 5

	Percent irrigigated area				Total fertiliser consumption		
	1980-83	1990-93	1999-02		1980-81	1991-92	2001-02
AGRA	0.50	0.62	0.61		41.62	78.54	126.15
ALIGARH	0.71	0.85	0.81		44.82	72.36	127.06
ALLAHABAD	0.37	0.63	0.67		43.30	104.81	159.20
AZAMGARH	0.49	0.60	0.72		42.13	82.12	109.65
BAHRAICH	0.15	0.20	0.28		27.86	43.84	67.88
BALLIA	0.40	0.63	0.67		70.20	99.16	112.87
BANDA	0.21	0.31	0.36		9.12	22.99	32.73
BARABANKI	0.43	0.72	0.81		47.67	96.07	151.26
BAREILLY	0.45	0.80	0.92		47.37	134.25	152.29
BASTI	0.42	0.46	0.50		34.87	81.43	162.73
BIJNOR	0.53	0.74	0.81		65.10	123.73	148.66
BUDAUN	0.40	0.62	0.75		43.30	95.71	119.87
BULANDSHAHAR	0.84	0.97	0.98		80.03	93.20	138.86
DEORIA	0.48	0.54	0.64		67.34	151.63	171.31
ETAH	0.58	0.74	0.82		34.93	76.34	111.38
ETAWAH	0.62	0.71	0.75		42.47	63.93	95.29
FAIZABAD	0.51	0.75	0.90		70.37	127.50	197.61
FARRUKHABAD	0.50	0.72	0.72		73.40	118.45	183.83
FATEHPUR	0.36	0.57	0.66		30.77	83.68	137.28
GHAZIABAD	0.82	0.96	1.00		71.36	121.80	202.62
GHAZIPUR	0.50	0.72	0.83		73.67	115.71	141.62
GONDA	0.27	0.34	0.38		33.80	46.23	87.34
GORAKHPUR	0.43	0.47	0.54		51.76	96.15	135.09
HAMIRPUR	0.16	0.29	0.33		6.67	20.29	34.47
HARDOI	0.47	0.56	0.73		28.79	55.23	80.30
JALAUN	0.27	0.35	0.42		14.85	39.17	74.37
JAUNPUR	0.47	0.68	0.78		76.00	112.64	111.43
JHANSI	0.29	0.36	0.46		15.96	31.27	64.33
KANPUR	0.50	0.60	0.67		41.16	96.52	128.49
KHERI	0.24	0.53	0.71		47.54	111.60	131.11
lalitpur	0.26	0.46	0.55		18.53	39.96	38.12
LUCKNOW	0.52	0.78	0.81		70.26	124.97	143.84
MAINPURI	0.43	0.79	0.82		37.77	88.26	150.43
MATHURA	0.65	0.77	0.76		32.68	65.05	108.69
MEERUT	0.88	0.99	1.00		100.57	124.13	209.20
MIRZAPUR	0.34	0.39	0.47		27.11	39.44	66.01
MORADABAD	0.59	0.81	0.86		57.64	126.09	168.18
MUZAFFARNAGAR	0.79	0.92	0.98		75.44	134.60	218.58
PILIBHIT	0.56	0.89	0.94		65.79	140.61	176.62
PRATAPGARH	0.46	0.65	0.81		55.96	87.12	122.98
RAEBARELI	0.48	0.81	0.84		43.15	75.49	111.06
RAMPUR	0.54	0.88	0.95		76.50	129.09	125.15
SAHARANPUR	0.61	0.77	0.86		68.90	136.05	171.58
SHAJHANPUR	0.51	0.80	0.91		55.33	102.60	175.68
SITAPUR	0.29	0.44	0.67		28.20	64.23	139.00
SULTANPUR	0.37	0.54	0.69		49.62	75.76	101.57
UNNAO	0.52	0.70	0.81		35.62	75.45	111.90
VARANASI	0.59	0.73	0.81		66.49	131.62	214.89
UTTAR PRADESH	0.46	0.62	0.71		47.35	88.71	129.77

Table 6

Rainfall in kharif season

DISTRICT	1980-81	1991-92	2001-02
AGRA	780.2	362.3	584.3
ALIGARH	678.1	478.1	579.5
ALLAHABAD	1313.9	585.8	865.4
AZAMGARH	1145.1	1185.1	899.7
BAHRAICH	1399.2	1175.5	994.5
BALLIA	1159.6	596.4	892.2
BANDA	1492.6	796.4	850.6
BARABANKI	1789.4	963.3	883.3
BAREILLY	839.1	489.9	959.7
BASTI	1555.4	706.4	1099.7
BIJNOR	785.5	664.7	947.5
BUDAUN	884	708.3	710.8
BULAND SHAHR	683.2	659.3	582
DEORIA	1635.3	1031.6	988.2
ETAH	801.6	535	612.1
ETAWAH	1113.9	542.8	669.1
FAIZABAD	1849.4	807.9	891.3
FARRUKHABAD	614.2	572.3	705
FATEHPUR	1639.1	391.3	806.3
GHAZIABAD	471.5	939.3	598.7
GHAZIPUR	1010.6	797.8	926.4
GONDA	1814.6	844.1	1009.8
GORAKHPUR	1836	1403.7	1182.1
HAMIRPUR	1814.3	854.9	768.7
HARDOI	1343.1	628.8	767.9
JALAUN	1572.5	681.2	704.8
JAUNPUR	1164.8	1015.5	885.1
JHANSI	1047.2	800.5	797.2
KANPUR	1399.3	566.8	713.1
KHERI	1379.2	788.9	921.8
LALITPUR	1081.2	683.2	797.2
LUCKNOW	1984.5	765.4	848.4
MAINPURI	867.1	404.1	630.4
MATHURA	567	486.2	518.7
MEERUT	698.8	614.2	598.7
MIRZAPUR	921.9	997.7	997.9
MORADABAD	707.8	683.1	815.4
MUZAFFAR NAGAR	603.5	543	639.5
PILIBHIT	891.4	657.5	1085.4
PRATAPGARH	2048.3	704.7	868.7
RAEBAREILY	1577.9	424.6	825.1
RAMPUR	929.8	681.2	815.4
SAHARANPUR	920.8	525.3	788.6
SHJAHANPUR	1171.9	603.2	890.8
SITAPUR	1181.2	618.2	849.8
SULTANPUR	1734.9	746.7	886.7
UNNAO	1478.6	650.8	742.3
VARANASI	936.2	962.4	926.4
UTTAR PRADESH	1194.056	715.1125	819.2125

Table 7

Rainfall in Rabi Season

DISTRICT	1980-81	1991-92	2001-02
AGRA	34.48	28.56	41.52
ALIGARH	43.68	25.44	45.6
ALLAHABAD	37.04	18.16	71.12
AZAMGARH	17.2	14.32	74.96
BAHRAICH	38	15.12	84
BALLIA	22.4	2	73.12
BANDA	49.6	22.96	61.36
BARABANKI	17.68	31.36	73.04
BAREILLY	46.56	34.32	84.8
BASTI	11.44	15.44	85.92
BIJNOR	91.84	90.88	92.4
BUDAUN	49.68	24.08	62.16
BULAND SHAHR	63.2	32.32	51.12
DEORIA	46.16	0	77.92
ETAH	49.52	26.64	48
ETAWAH	27.12	31.44	48.48
FAIZABAD	32.32	17.76	71.36
FARRUKHABAD	34.64	39.28	52.4
FATEHPUR	39.84	26.4	58.64
GHAZIABAD	58.4	116.72	66
GHAZIPUR	48.72	17.44	79.76
GONDA	54.4	14.88	76.56
GORAKHPUR	33.2	5.6	89.84
HAMIRPUR	28.96	28.8	51.6
HARDOI	35.76	34.8	62.64
JALAUN	17.52	28.16	49.28
JAUNPUR	27.28	14.64	72.88
JHANSI	5.04	35.6	51.92
KANPUR	32.64	52.32	53.92
KHERI	55.2	68.24	80.48
LALITPUR	19.92	10.96	52.72
LUCKNOW	20.16	25.92	64.64
MAINPURI	26	30.4	53.2
MATHURA	22.96	18.4	41.04
MEERUT	92.4	70.48	66
MIRZAPUR	70.88	14	86.16
MORADABAD	61.12	75.76	73.28
MUZAFFAR NAGAR	77.2	62.08	68
PILIBHIT	38.32	39.44	86.96
PRATAPGARH	18.48	30.88	67.6
RAEBAREILY	19.52	14.72	63.2
RAMPUR	71.04	52.8	73.28
SAHARANPUR	154.48	48.08	92.72
SHJAHANPUR	33.84	39.44	73.2
SITAPUR	12.32	70.32	72
SULTANPUR	22.56	25.36	70.96
UNNAO	31.12	39.04	59.6
VARANASI	42.56	28.88	81.76
UTTAR PRADESH	41.34167	33.555	67.48167

Table 8
Agricultural Workers

	1981	1991	2001
AGRA	380719	430190	392857
ALIGARH	459441	557548	711036
ALLAHABAD	655093	797441	1343271
AZAMGARH	625366	728333	1243839
BAHRAICH	633633	746465	1119061
BALLIA	341023	347651	562964
BANDA	362613	441521	753799
BARABANKI	530633	600836	779445
BAREILLY	467177	552096	646035
BASTI	856178	894179	1685665
BIJNOR	358931	453525	509265
budaun	536459	630079	718830
BULANDSHAHAR	423132	486601	740580
DEORIA	701982	837857	1397204
ETAH	432235	501069	588136
ETAWAH	361047	438311	533624
FAIZABAD	501500	596776	1136397
FARRUKHABAD	444064	534774	637195
FATEHPUR	350882	403882	682988
GHAZIABAD	180023	254137	229148
GHAZIPUR	342241	417417	693809
GONDA	763267	898163	1409024
GORAKHPUR	760336	870923	1470373
HAMIRPUR	267212	329246	548349
HARDOI	605209	708673	863047
JALAUN	209146	255399	395991
JAUNPUR	448509	513815	886254
JHANSI	318209	397780	393122
KANPUR	503263	544885	769736
KHERI	543625	622325	796645
Lalitpur	170012	235001	341038
LUCKNOW	250103	271602	345753
MAINPURI	383663	446531	608516
MATHURA	285571	329379	441922
MEERUT	679026	779482	558406
MIRZAPUR	400180	484988	848301
MORADABAD	630442	771140	955113
MUZAFFARNAGAR	453146	558030	691794
PILIBHIT	245055	290822	330833
PRATAPGARH	359176	404567	727177
RAEBARELI	429565	482482	800490
RAMPUR	261117	316663	360857
SAHARANPUR	492968	559638	428401
SHAJHANPUR	415710	482416	531028
SITAPUR	622392	734171	891409
SULTANPUR	447311	537434	768487
UNNAO	431980	504168	702230
VARANASI	468872	559762	807931

Table 9

Workers per 1000 hectare

	1980	1991	2001
AGRA	805	1156	931
ALIGARH	701	910	1070
ALLAHABAD	1036	1262	1998
AZAMGARH	983	1082	1846
BAHRAICH	931	1116	1619
BALLIA	963	1074	1707
BANDA	615	802	1287
BARABANKI	1185	1324	1776
BAREILLY	975	1149	1242
BASTI	1072	1107	2158
BIJNOR	761	1022	1152
BUDAUN	966	1052	1071
BULANDSHAHAR	742	851	1206
DEORIA	1076	1335	2252
ETAH	928	1026	1113
ETAWAH	915	1029	1173
FAIZABAD	1105	1356	2167
FARRUKHABAD	1078	1316	1394
FATEHPUR	889	1092	1722
GHAZIABAD	582	845	996
GHAZIPUR	936	1130	1760
GONDA	983	1280	1884
GORAKHPUR	1049	1207	2068
HAMIRPUR	507	651	967
HARDOI	1096	1251	1316
JALAUN	570	728	1061
JAUNPUR	1055	1201	2077
JHANSI	929	1139	949
KANPUR	910	982	1321
KHERI	892	989	1137
lalitpur	742	904	1036
LUCKNOW	1239	1374	1641
MAINPURI	913	858	1045
MATHURA	651	814	943
MEERUT	1352	1527	1110
MIRZAPUR	778	963	1521
MORADABAD	897	1065	1205
MUZAFFARNAGAR	861	1142	1447
PILIBHIT	709	822	925
PRATAPGARH	1202	1256	2236
RAEBARELI	1156	1224	1996
RAMPUR	895	1016	1013
SAHARANPUR	819	891	977
SHAJHANPUR	850	879	887
SITAPUR	1139	1356	1447
SULTANPUR	1056	1292	1812
UNNAO	1121	1244	1594
VARANASI	1005	1162	1696

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