CHAPTER IV

DISTRIBUTION OF POTATO AREA AND PRODUCTION

INDIA AND SELECTION OF STUDY REGION.
Chapter - IV

DISTRIBUTION OF POTATO AREA AND PRODUCTION IN INDIA AND SELECTION OF STUDY REGION

The purpose of this chapter is to study the extent of localization of potato production at all India level. In this respect, the existing regional distribution pattern of this crop is examined in the background of changing area and production shares of different states between 1955-56 and 1980-83. Further, the regional concentration at district level has also been discussed and the important potato growing districts have been identified on the basis of their contribution to potato production at state and national level. Then the growth rates of potato area, yield and production are analysed to highlight the varying role of area and yield in production of potato in different regions. The change in production is further decomposed into area, yield and their interaction effects through the component approach to compare the contribution of each component over the regions. The above analysis will also pave a way for the selection of Uttar Pradesh as a region of the present study. The next section of this chapter describes the brief profile of this state as regards the agroclimatic conditions and production practices.

SECTION 'A'

Present Regional Distribution Pattern

At world level, potato is the fourth important individual crop in terms of acreage. During the triennium 1979-82, the crop
was grown on an average area of 18 million hectares with an average production of 258 million tonnes per year (Table 4.1). Though, the crop is cultivated in a large number of countries, the European countries and U.S.S.R. which have cool temperate climate suitable for its production account for about two thirds of its global acreage and production. Among the individual countries, U.S.S.R. alone contributed for about 30 percent of world production followed by 15 percent by Poland, 6 percent by U.S.A. and China each, 4 percent by Germany (Democratic Republic) and 4 percent by India during the above triennium. In terms of acreage, U.S.S.R. accounted for 38 percent of world potato area followed by 13 percent by Poland, 8 percent by China, 4 percent by India and 3 percent by Germany (D.R) and U.S.A. each. The average yield per hectare in this triennium was 142 quintals with the highest yield at 376 quintals in Netherlands followed by 320 quintals in United Kingdom and 300 quintals in Germany (D.R) and U.S.A. The average yield per hectare is the lowest, 99 quintals in China followed in ascending order by 111 quintals in U.S.S.R. and 128 quintals in India.

In India, Potato is not among the major traditional crops but its rapid growth over the last two decades has made it important in the agricultural economy of the country. The crop is cultivated all over the country except Kerala. The temperate climate of Indo-gangetic plains and the hills of eastern India and

1. Government of India, Economic Survey, 1978-79 observes* An important development in the changing cropping mix in the country is the large increase in the production of Potatoes. While the shares of these items in the total weights in the agricultural index is not large, the economic importance of high value cash crops and those for export is obvious(P.6)
### Country-wise Area, Production and Yield of Potatoes in the World (Average of Triennium ending 1981-82)

<table>
<thead>
<tr>
<th>Country</th>
<th>Area in (000 hec.)</th>
<th>Percentage to world Potato area</th>
<th>Production in (000 tonnes)</th>
<th>Percentage to world potato production</th>
<th>Yield per hectare (in quintals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.S.R.</td>
<td>6919</td>
<td>38.20</td>
<td>76661</td>
<td>29.73</td>
<td>110.80</td>
</tr>
<tr>
<td>Poland</td>
<td>2348</td>
<td>12.96</td>
<td>39521</td>
<td>15.33</td>
<td>168.32</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>493</td>
<td>2.72</td>
<td>14802</td>
<td>5.74</td>
<td>300.24</td>
</tr>
<tr>
<td>China</td>
<td>1484</td>
<td>8.19</td>
<td>14704</td>
<td>5.70</td>
<td>99.08</td>
</tr>
<tr>
<td>India</td>
<td>728</td>
<td>4.02</td>
<td>9281</td>
<td>3.60</td>
<td>127.54</td>
</tr>
<tr>
<td>German D.R.</td>
<td>527</td>
<td>2.91</td>
<td>106.56</td>
<td>4.13</td>
<td>202.20</td>
</tr>
<tr>
<td>German F.R.</td>
<td>305</td>
<td>1.68</td>
<td>8740</td>
<td>3.39</td>
<td>286.56</td>
</tr>
<tr>
<td>France</td>
<td>235</td>
<td>1.30</td>
<td>6733</td>
<td>2.61</td>
<td>286.51</td>
</tr>
<tr>
<td>U.K.</td>
<td>205</td>
<td>1.13</td>
<td>6567</td>
<td>2.55</td>
<td>320.34</td>
</tr>
<tr>
<td>Netherland</td>
<td>168</td>
<td>0.93</td>
<td>6330</td>
<td>2.45</td>
<td>376.79</td>
</tr>
<tr>
<td>Spain</td>
<td>405</td>
<td>2.24</td>
<td>5648</td>
<td>2.19</td>
<td>139.46</td>
</tr>
<tr>
<td>Romania</td>
<td>293</td>
<td>1.62</td>
<td>4792</td>
<td>1.86</td>
<td>163.55</td>
</tr>
<tr>
<td>Czechoslovak</td>
<td>201</td>
<td>1.11</td>
<td>3586</td>
<td>1.39</td>
<td>178.41</td>
</tr>
<tr>
<td>Italy</td>
<td>160</td>
<td>0.88</td>
<td>2960</td>
<td>1.15</td>
<td>185.00</td>
</tr>
<tr>
<td>Japan</td>
<td>128</td>
<td>0.71</td>
<td>3357</td>
<td>1.30</td>
<td>262.27</td>
</tr>
<tr>
<td>Turky'</td>
<td>181</td>
<td>1.00</td>
<td>2950</td>
<td>1.14</td>
<td>162.98</td>
</tr>
<tr>
<td>Others</td>
<td>3239</td>
<td>17.88</td>
<td>40552</td>
<td>15.73</td>
<td>125.20</td>
</tr>
<tr>
<td>Total World</td>
<td>18111</td>
<td>100.00</td>
<td>257839</td>
<td>100.00</td>
<td>142.37</td>
</tr>
</tbody>
</table>

**Note:** 1. Average of 1980-81 and 1981-82

### Table - 4.2

State-wise Annual Area, Production and Yield of Potatoes in INDIA (Average of Trinmium Ending 1982-83)

<table>
<thead>
<tr>
<th>State</th>
<th>Area in 000 hectares</th>
<th>Percentage of All India</th>
<th>Production 000 tonnes</th>
<th>Percentage to All India</th>
<th>Yield per hectare in quintals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uttar Pradesh</td>
<td>282.37</td>
<td>37.88</td>
<td>4366.85</td>
<td>44.23</td>
<td>154.65</td>
</tr>
<tr>
<td>Bihar</td>
<td>131.97 (99.1)</td>
<td>17.64</td>
<td>1174.67 (775.20)</td>
<td>11.90</td>
<td>89.01 (78.22)</td>
</tr>
<tr>
<td>West Bengal</td>
<td>116.47 (2.1)</td>
<td>15.57</td>
<td>2086.17 (17.5)</td>
<td>21.13 (0.84)</td>
<td>179.12 (83.33)</td>
</tr>
<tr>
<td>Assam</td>
<td>40.77</td>
<td>5.45</td>
<td>252.30</td>
<td>2.56</td>
<td>61.89</td>
</tr>
<tr>
<td>Punjab</td>
<td>33.80</td>
<td>4.52</td>
<td>642.93</td>
<td>6.51</td>
<td>190.21</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>26.73 (22.8)</td>
<td>3.57</td>
<td>298.87 (289.4)</td>
<td>3.03 (96.93)</td>
<td>111.85 (126.93)</td>
</tr>
<tr>
<td>Meghalaya</td>
<td>17.40</td>
<td>2.33</td>
<td>129.59</td>
<td>1.31</td>
<td>74.42</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>14.20 (0.5)</td>
<td>11.90</td>
<td>48.20 (2.8)</td>
<td>0.49 (5.81)</td>
<td>33.94 (56.00)</td>
</tr>
<tr>
<td>Haryana</td>
<td>10.87</td>
<td>1.45</td>
<td>170.87</td>
<td>1.73</td>
<td>157.19</td>
</tr>
<tr>
<td>Gujarat</td>
<td>11.53</td>
<td>1.54</td>
<td>304.07</td>
<td>3.08</td>
<td>264.43</td>
</tr>
<tr>
<td>Karnataka</td>
<td>12.33 (2.1)</td>
<td>1.65</td>
<td>89.57 (17.4)</td>
<td>0.91 (19.43)</td>
<td>72.85 (82.86)</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>11.10 (2.7)</td>
<td>1.48</td>
<td>93.20 (18.1)</td>
<td>0.94 (19.42)</td>
<td>83.96 (67.04)</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>11.50 (6.00)</td>
<td>1.54</td>
<td>60.33 (25.2)</td>
<td>0.61 (41.79)</td>
<td>52.43 (42.00)</td>
</tr>
<tr>
<td>Orissa</td>
<td>9.03</td>
<td>1.21</td>
<td>64.40</td>
<td>0.65</td>
<td>71.56</td>
</tr>
<tr>
<td>Nagaland</td>
<td>5.03</td>
<td>0.67</td>
<td>30.93</td>
<td>0.31</td>
<td>61.80</td>
</tr>
<tr>
<td>Tripura</td>
<td>2.47</td>
<td>0.33</td>
<td>35.80</td>
<td>0.36</td>
<td>14.32</td>
</tr>
<tr>
<td>Manipur</td>
<td>2.00</td>
<td>0.27</td>
<td>12.80</td>
<td>0.13</td>
<td>64.00</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>2.03</td>
<td>0.27</td>
<td>3.07</td>
<td>0.03</td>
<td>15.50</td>
</tr>
<tr>
<td>Jammu &amp; Kashmir</td>
<td>1.60</td>
<td>0.21</td>
<td>3.33</td>
<td>0.03</td>
<td>20.63</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>0.33</td>
<td>0.04</td>
<td>0.93</td>
<td>Neg</td>
<td>30.00</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>744.00</td>
<td>99.52</td>
<td>9867.00</td>
<td>99.94</td>
<td>132.38</td>
</tr>
<tr>
<td><strong>All India</strong></td>
<td>748.00 (136.1)</td>
<td>100.00</td>
<td>9873.00 (1147.6)</td>
<td>100.00</td>
<td>132.38</td>
</tr>
</tbody>
</table>

Note: Figures in bracket are summer statistics of the year 1980-81 only. In the percentage column, the percentage of summer season crop in the total of respective state is shown.
Himachal Pradesh is more suitable for the crop. These areas account for nine-tenth of Potato area and production during the triennium 1980-83. The state wise area and production of potato in table 4.2 point out these features about the regional distribution of this crop.

During 1980-83, the average annual area under Potato was 0.8 million hectares which constitutes about half percent of gross cropped area in India. The average annual production was 9.9 million tonnes with an average yield of 133 quintals during this period. Uttar Pradesh, Bihar and West Bengal accounted for 38 percent, 18 percent and 16 percent of all India Potato acreage respectively in the above period. The percentage of area varied between 2 to 5 percent in case of Assam, Punjab, Madhya Pradesh and Meghalaya. Each of Himachal Pradesh, Haryana, Gujrat, Karnataka, Tamil Nadu, Orissa and Maharastra account for 1 to 2 percent of all India potato acreage. Each of the remaining states and union territories account for less than one percent of all India Potato acreage.

In terms of production, Uttar Pradesh, West Bengal and Bihar contributed about 44 percent, 21 percent and 12 percent of all India potato production, respectively during 1980-83. Punjab, Guajarat, Madhya Pradesh and Assam account for 6.5, 3, 3 and 2.6 percents of the country's production in this period. Haryana and Meghalaya contribute between one to two percent each and each of the remaining states and Union territories contribute less than one percent of all India production. The statewise distribution of Potato area and production is also illustrated in figure 4.1.
Fig. 41: State-wise percentage share of all India potato area and production (based on average of triennium ending 1982-83).

Fig. 43: Changes in percentage shares of important states in all India potato area and production, during 1960-83.
The yield per hectare is the highest at 264 quintals in Gujarat followed by 190 quintals in Punjab, 179 quintals in West Bengal and about 155 quintals in Haryana and Uttar Pradesh during 1980-83. Among the major potato producing states, Bihar has the lowest yield of 89 quintals per hectare. In other states excluding Madhya Pradesh (112 quintals) the yield per hectare varies over a wide range of 21 quintals to 85 quintals.

Summer and winter seasons are the important production periods for Potato. About 82 percent of area and 88 percent of Potato production are contributed by its winter crop alone. The summer crop is mainly confined to the states of Bihar, Madhya Pradesh, Maharashtra, Tamil Nadu and Karnataka. West Bengal also cultivates some summer potato in the areas adjoining to Chhotanagpur plateau.

The localization of Potato cultivation is also discussed at district level to observe the extent of regional concentration irrespective of state boundaries. In this regard only those districts have been considered in which the absolute potato area is more than 1000 hectares and its minimum contribution to gross cropped area is equal to or more than 0.25 percent. There were 125 such districts throughout the country during 1976-78 (Appendix 4.1). These districts have been further classified into four categories in Table 4.3 on the basis of the share of Potato area in the GCA of the relevant district to depict them on the map of India² (figure 4.2).

² These 125 districts do not include the districts of Meghalaya, Nagaland and Manipur for which districtwise break up could not be available and these states have been depicted on the basis of state level data.
### Classification of Important Potato Growing Districts Of India (On the basis of Percentage of Potato area in their Respective Gross Cropped area)

<table>
<thead>
<tr>
<th>Percentage of Potato Area to GCA</th>
<th>States and Their Districts (Alongwith code Number of the district on the Map)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00 and Above (16)</td>
<td>Uttar Pradesh - Farrukhabad(341), Mainpuri(340), Jaunpur(367), Lucknow(355); Bihar - Nalanda(35), Saran(41), Gopalganj(43), Hazaribagh(61), Giridih(60); West Bengal - Howrah(381), Hooghly(382), Burdwan(386), Birbhum(387); Punjab - Jalandhar(259), Hoshiarpur(261); Himachal Pradesh - Simla(104);</td>
</tr>
<tr>
<td>1.00 - 1.99 (46)</td>
<td>Uttar Pradesh - Badaun (332), Bulandshahr (329), Etawah (342), Etah (339), Kanpur (343), Allahabad (345), Hardoi (353), Barabanki (359), Faizabad (360), Sultanpur (361), Pratapgarh (362), Ballia (368), Ghazipur (369), Varanasi (370), Dehradun (319), Meerut (327-28); Bihar - Patna (34), Gaya (37), Nawadah (36), Bhojpur (40), Siwan (42), Muzaffarpur (47), Sitamarh (46), Vaishali (48), Darbhanga (51), Madhubani (52), Samastipur (50), Katihar (55), Begusarai (40), Munger (36), Champaran West (44), Ranchi (63); West Bengal - Jalpaiguri (373), Cooch Bihar (372), West Dinajpur (375), Bankura (384), Midnapur (383), Darjeeling (374), Murshidabad (377); Tamil Nadu - The Nilgiris (305); Mandi (101) of Himachal Pradesh; Karnataka - Hassen (128), Madhya Pradesh - Indore (175); Jammu and Kashmir - Srinagar (115); Assam - Goalpara (369); Haryana - Ambala (84);</td>
</tr>
<tr>
<td>0.50 - 0.99 (42)</td>
<td>Uttar Pradesh - Moradabad (330), Rampur (331), Bareilly (333), Shahjahanpur (335), Agra (338), Fatehpur (344), Unnao (354), Rae-Bareli (350), Basti (363), Gorakhpur (364), Deoria (365), Azamgarh (366), Mirzapur (371), Pithoragarh (321), Nainital (323); Bihar - Aurangabad (38), Champaran East (45), Rohtas (39), Bhagalpur (57), Santhal Parganas (53), Saharsa (53), Purnea (54), Palamu (62); W. Bengal - Malda (376), West Dinajpur (375), Nadia (378), 24-Parganas (379); Assam - Cachar (24), Kamrup (27), Darrang (28), Lakhimpur (32), Dibrugarh (33); Haryana-Karnal; Kurukshetra (86); Punjab - Rupnagar (262); Madhya Pradesh - Gwalior (155); Tamil Nadu - Madurai (306), Maharashta - Poona (203), Satara (204); Karnataka - Chikmagalur (130), Kolal (1);</td>
</tr>
<tr>
<td>0.25 - 0.49 (21)</td>
<td>Uttar Pradesh - Pilibhit (334), Saharanpur (324), Muzaffarnagar (325), Kheri (351), Sitapur (37), Mathura (337), Behraich (357), Gonda (358), Bijnor (326); Bihar - Singhbhum (64); W. Bengal - Purulia (385); Punjab - Ludhiana (258); J &amp; K - Baramullah (113), Assam - Sibsagar; Orissa - Cuttack (247); Karnataka - Timkur (123), Belgaum (136), Madhya Pradesh - Chhindwara (186), Surguja (194), Tikamgarh (159);</td>
</tr>
</tbody>
</table>

**Note:**

1. A district having less than 1000 hectares of land under potato was not considered even this area is more than 0.25 percent of its gross cropped area.

2. The above classification is based upon the data between the triennium 1976-79, however, in some states data of either one or two years of this triennium also forms the basis. Some states like Meghalaya, Nagaland, Tripura have more than 2 percent of their GCA under Potato but their districwise break up was not available.
Of those districts, 16 districts have 2 percent or more of their GCA under potato and another 46 districts cultivate potato on 1.00 to 2.00 percent of their GCA. Of the remaining 63 districts, 42 districts have potato area between 0.50 to 1.00 percent of their GCA and 21 districts have potato area between 0.25 to 0.50 percent of their individual gross cropped area.

The other important observations relating to the extent of regional distribution at micro-level are the following:

The above 125 districts account for 91.4 percent and 92.4 percent of all India Potato area and production, respectively during 1976-77/1978-79. Individually, only 30 districts contribute more than one percent of either all India area or production or both. Out of these, Farrukhabad, Hooghly and Burdwan contribute 5.36 percent, 6.79 percent and 5.4 percent of all India Potato production, respectively. The other districts which individually contribute more than 2 percent of all India production are Jullundhar (3.51 percent), Midnapore (3.09 percent) and Hoshiarpur (2.7 percent)

Out of 125 districts, 92 districts which account for 76 percent of India's Potato production are continuously spread along the river ganga and its tributaries in the states of Uttar Pradesh, Bihar and Bengal. Another 20 districts which contribute about 12 percent of all

3. The other 24 districts which contribute between 1 to 2 percent of all India potato area or production are: Meerut, Bulandshahar, Badaun, Etah, Mainpuri, Etawah, Kanpur, Allahabad, Hardoi, Faizabad, Basti, Jaunpur of Uttar Pradesh; Nalanda, Gaya, Saran, Purnea, Hazaribagh, Ranchi of Bihar; West Dinajpur, Murshidabad, Bankura, Birbhum of West Bengal; Jullundhar and Hoshiarpur of Punjab; Simla in Himachal Pradesh and the Nilgiris in Tamil Nadu. This criteria is not an approximate indicator of concentration so far as the size of district may influence its potato area and production. Hence the criteria of percentage of potato area to the GCA of the district concerned was considered to depict the regional concentration on the map.
India potato production are located in the basins of the Indus and Brahmputra in the states of Punjab, Haryana, Himachal Pradesh and Assam. Thus, potato production from all India point of view, is mainly confined to Indo-gangetic and Brahmputra basins which comprise the entire longitudinal extent of the Himalayan plains from Punjab to Assam.

Potato area is almost evenly distributed among the districts of Uttar Pradesh, Bihar and West Bengal. Farrukhabad, Hooghly and Burdwan are the only districts in these states which individually account for more than 10 percent of their respective state potato areas. In other potato cultivating states, it has been observed that only one or two districts are important contributors, each accounting between 30 to 40 percent of the potato area of the state.

Changes in the Regional Distribution over time.

As stated earlier, Potato production in India reached its present optimum level of 10.13 million tonnes in 1978-79 from a low level of 1.66 million tonnes in 1950-51.\(^4\) It's production level was almost stagnant upto 1957-58 and since then it has continuously increased with an increasing rate. How this increasing production has affected the extent of regional concentration of this crop during 1955-83, is examined through (a) the changes in percentage shares of different states in the all India potato area and production (b) the rates of growth of area and production of potato in different states.

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\(^4\) The production was below this level during 1979-80 to 1982-83 but again crossed this peak in 1983-84 with production level of 12.25 million tonnes.
The triennium averages of the percentage shares of area and production of Potato for different states in the all India Potato area and production at the interval of five years during 1955-83, are presented in table 4.4. The statewise distribution does not record any perceptible change between 1955-58 and 1960-63 but afterwards there is an indication towards a continuous change in regional distribution. The states which have gained in their percentage shares are Uttar Pradesh, Punjab, Haryana and Gujarat. Among them, the contribution of Uttar Pradesh, Punjab and Haryana in the all India potato area has increased from 35.78 percent during 1960-63 to 44.02 percent during 1980-83 and the share of their production was 32.77 percent and 52.47 percent in the corresponding points of time (figure 4.3). On the other hand, the states of Bihar, Assam, Himachal Pradesh, Karnataka, Meghalaya, Tamil Nadu and Orissa have recorded decrease in their percentage shares of area and production during 1960-83. Among them, the percentage shares of Bihar, Assam and Meghalaya in the all India Potato area has decreased from 29.75 percent during 1960-63 to 25.68 percent during 1980-83 and their contribution in production decreased from 25.70 percent to 15.77 percent in the above period. The share of remaining states including West Bengal, the third important state in terms of potato area and second in terms of production has either remained unchanged or observed little changes.

The above changes in the percentage shares of different states indicate increasing localisation of the crop over the last two
Table - 4.4
State-wise Percentage Area and Production during 1955-56 to 1982-83

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Uttar Pradesh</td>
<td>33.57</td>
<td>32.08</td>
<td>30.53</td>
<td>34.88</td>
<td>31.90</td>
<td>38.00</td>
</tr>
<tr>
<td>2</td>
<td>Bihar</td>
<td>17.79</td>
<td>20.59</td>
<td>19.53</td>
<td>20.10</td>
<td>21.49</td>
<td>17.77</td>
</tr>
<tr>
<td>3</td>
<td>West Bengal</td>
<td>16.38</td>
<td>16.32</td>
<td>16.10</td>
<td>15.00</td>
<td>15.69</td>
<td>15.68</td>
</tr>
<tr>
<td>4</td>
<td>Assam</td>
<td>9.72</td>
<td>9.16</td>
<td>7.83</td>
<td>5.16</td>
<td>4.58</td>
<td>5.49</td>
</tr>
<tr>
<td>5</td>
<td>Meghalaya</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.02</td>
<td>2.42</td>
</tr>
<tr>
<td>6</td>
<td>Punjab</td>
<td>2.97</td>
<td>3.02</td>
<td>2.88</td>
<td>3.20</td>
<td>4.11</td>
<td>4.55</td>
</tr>
<tr>
<td>7</td>
<td>Haryana</td>
<td>-</td>
<td>0.68</td>
<td>0.68</td>
<td>0.97</td>
<td>1.56</td>
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</tr>
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<td>3.21</td>
<td>3.83</td>
<td>3.04</td>
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<td>Gujarat</td>
<td>-</td>
<td>0.55</td>
<td>0.74</td>
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<td>1.66</td>
<td>1.65</td>
</tr>
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<td>2.97</td>
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<tr>
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<td>6.31</td>
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<td>3.33</td>
<td>3.17</td>
<td>3.59</td>
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<tr>
<td>15</td>
<td>Others</td>
<td>9.83</td>
<td>2.15</td>
<td>2.44</td>
<td>1.51</td>
<td>1.12</td>
<td>1.80</td>
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<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(296)</td>
<td>(2000)</td>
<td>(384)</td>
<td>(2842)</td>
<td>(489)</td>
<td>(3943)</td>
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<td></td>
<td>(503)</td>
<td>(4695)</td>
<td>(636)</td>
<td>(7543)</td>
<td>(743)</td>
<td>(9873)</td>
</tr>
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</table>

2 + 4 + 5    | 27.51    | 20.42   | 29.75   | 25.70   | 27.36   | 24.77   | 28.28   | 24.81   | 29.18   | 19.46   | 25.68   | 15.77   |
1 + 6 + 7    | 36.54    | 43.88   | 35.78   | 32.77   | 34.09   | 37.49   | 39.05   | 40.83   | 37.87   | 47.00   | 44.02   | 52.47   

Note: Area and Production figures are in percentages.
decades. The other important development is that the percentage shares of production of both the above mentioned losser and gainer groups of states were less than their corresponding share of area during 1960-63 which implies that their yield level were less than or comparable to yield levels of remaining states at that time. But the share of production compared to that of area has been increas­ingly high in case of Uttar Pradesh, Punjab and Haryana after 1960-63. Whereas the pattern was just the opposite in case of most of the other states. This trend is clearly depicted in figure 4.3 in which percentage shares of area and production of the above groups of states have been plotted against time. Hence, the increasing yield, probably due to speedy adoption of new Potato technology in Uttar Pradesh (especially in its western districts which have recorded higher increase in potato area and production), Punjab and Haryana may have been a major inducing factor for the increasing potato area in the physio-climatically suitable areas of these states.

5. This trend is also implied in the increasing coefficient of variation of potato area and production of different states during 1960-81. The coefficient of variation of the potato area of different states were 111.45, 138.90 and 144.49 percent during 1960-63, 1970-73 and 1978-81, respectively and coefficient of variation of their production during the corresponding points of time were 112.59, 144.53 and 166.24 percent, respectively.

6. In this respect it is to be noted that these states are also well known for the adoption of new agricultural technology (Biplab Dasgupta(1980)op.cit.). Moreover, the relative gain in their percentage share in all India potato production has started from 1965-68 which is also the time of introducing the technology comprising increased use of fertilizers, pesticide, new implements and high yielding varieties of seeds. In case of Potato, improved varieties were released during 1958-69(Appendix table 3.2). The 'seed plot technique' of producing disease free improved seeds in the plains was also introduced in late sixties. Government of Uttar Pradesh was ahead in taking steps for the development of this crop. (Govt. of India, Report of National Commission on Agriculture, Crop Production -Sericulture and Apiculture, Part IV (New Delhi : 1976) p.278.)
This point is further examined through the growth rates of potato area, production and yield in different states.

The growth rates of potato area in Table 4.5 show that Maharashtra and Orissa are the only states which have recorded a decrease in their absolute area during 1960-63 to 1978-81. The growth rates of potato area in Bihar, Assam and Meghalaya are positive but less than that of all India whereas the growth rate of potato area in West Bengal was in close proximity of all India during the above period. On the other hand, the growth rates of potato area in Uttar Pradesh, Punjab, Haryana and Gujarat are higher than of all India during 1960-83. And these are the states which have also recorded higher growth rates in their yield of potato than the all India yield. These trends are further clarified from the growth rates between 1970-73 and 1980-83. The yield of the crop again seems to emerge as a crucial factor in affecting the acreage planted under potato in the different agro-climatic regions leading to a regional concentration of potato. To study the specific effect of yield in output growth the latter has been decomposed into area effect, yield effect and their interaction effect through the component approach.

7. The yield growth rate of Haryana and Gujarat are shown less on the basis of 1978-81 data but the yield levels of potato in these states were much higher in 1976-77 and 1977-78.

8. The growth in output can be expressed as $\Delta O = Y_1 \Delta A + A_1 \Delta Y + \Delta A \Delta Y + \Delta O$ where $A_1$ and $Y_1$ are the potato area and yield in the base period and $\Delta A$, $\Delta Y$ and $\Delta O$ are the changes in area, yield and output, respectively during the period of change. The first term on the right hand side is the change in output due to change in area when yield remains constant. This is called area effect in the growth of output. Similarly, second term denotes yield effect and the third term denotes their interaction effect, i.e. change in output is assumed equal to 100 which is then shared in proportion to the values of above three terms to isolate the contribution of area, yield and interaction effect.
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<tr>
<td></td>
<td></td>
<td>A</td>
<td>P</td>
</tr>
<tr>
<td>1</td>
<td>Assam</td>
<td>0.39</td>
<td>1.77</td>
</tr>
<tr>
<td>2</td>
<td>Bihar</td>
<td>3.21</td>
<td>3.43</td>
</tr>
<tr>
<td>3</td>
<td>Gujarat</td>
<td>8.11</td>
<td>11.15</td>
</tr>
<tr>
<td>4</td>
<td>Haryana</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>H.Pradesh</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Karnataka</td>
<td>2.45</td>
<td>4.14</td>
</tr>
<tr>
<td>7</td>
<td>Madhya Pradesh</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Maharashtra</td>
<td>-1.94</td>
<td>-1.44</td>
</tr>
<tr>
<td>9</td>
<td>Meghalaya</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Orissa</td>
<td>-2.82</td>
<td>2.22</td>
</tr>
<tr>
<td>11</td>
<td>Punjab</td>
<td>-</td>
<td>-</td>
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<tr>
<td>12</td>
<td>Tamil Nadu</td>
<td>1.41</td>
<td>1.43</td>
</tr>
<tr>
<td>13</td>
<td>Uttar Pradesh</td>
<td>4.57</td>
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<td>14</td>
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<tr>
<td></td>
<td>All India</td>
<td>3.93</td>
<td>6.84</td>
</tr>
</tbody>
</table>

*The period between 1960-63 and 1978-81 may be called a high growth period for Potato and hence the triennia of its starting and end period are considered.

1. Peculiar production situation in terminal years was largely responsible.
2. Abnormal low yield in the years 1978-81 is largely responsible for the negative sign.
The percentage contribution of area, yield and their interaction effects in the output change of Potato during three periods of time\(^9\) i.e. 1960-83, 1960-73 and 1970-83 are presented in table 4.6 for the important states. It is apparent that the contribution of area effect is much higher in the output increase of Punjab, Haryana and Gujarat in all the three periods whereas the contribution of yield effect is relatively low. This is because the relative growth of their acreage under potato was much higher from their low initial base\(^10\). On the other hand, Uttar Pradesh having quite a large acreage of Potato in the initial period, has almost equal contribution of the area and yield components in the output growth. Similar position is emerging at all India level. However, the interaction effect in the output growth of Uttar Pradesh is higher than that of all India in all the three periods. The area effect was the major contributor to this state's output growth in sixties whereas the yield effect was dominant in seventies. In case of Bihar, the

\(^9\) The period 1960-83 represent total period of study. However in this case the triennium 1978-81 used in growth rates has been replaced by 1980-83 as the earlier one included two abnormal years 1978-79 and 1979-80. The periods 1960-73 and 1970-83 are considered to compare the effect of area and yield during sixties and seventies.

\(^10\) This point becomes more clear from the recent trend in potato acreage of these states. The potato acreage in Punjab, Haryana and Gujarat declined from 51.70 thousand hectares in 1978-79 to 48.30 thousand hectares in 1982-83. Whereas, the crop acreage of above states has increased from 19.70 thousand hectares in 1970-71 to 51.70 thousand hectares in 1978-79. There may be two possible reasons for this development. First, the yield levels of potato are stagnant in those states since 1978-79 which indicate exhaustion of the yield increasing incentive of the new technology. Secondly, the suitable area for potato cultivation have already been brought under the crop and further increase in its area may be on land which is less suitable for the crop.
## Table 4.6
Decomposition of Potato output Growth - State-wise.

<table>
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<tbody>
<tr>
<td></td>
<td>Annual Comp. growth</td>
<td>Percentage contribution to growth through Area</td>
<td>Yield</td>
<td>Interaction between area &amp; yield</td>
</tr>
<tr>
<td></td>
<td>Rate of output</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Uttar Pradesh</td>
<td>8.87</td>
<td>30.88</td>
<td>29.06</td>
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<tr>
<td>2</td>
<td>Punjab</td>
<td>8.57</td>
<td>58.16</td>
<td>17.36</td>
</tr>
<tr>
<td>3</td>
<td>Haryana</td>
<td>8.42</td>
<td>91.36</td>
<td>2.96</td>
</tr>
<tr>
<td>4</td>
<td>Gujarat</td>
<td>10.45</td>
<td>46.15</td>
<td>13.77</td>
</tr>
<tr>
<td>5</td>
<td>West Bengal</td>
<td>5.86</td>
<td>43.60</td>
<td>30.35</td>
</tr>
<tr>
<td>6</td>
<td>Bihar</td>
<td>3.53</td>
<td>66.59</td>
<td>20.09</td>
</tr>
<tr>
<td>7</td>
<td>Madhya Pradesh</td>
<td>4.54</td>
<td>72.65</td>
<td>13.31</td>
</tr>
<tr>
<td>8</td>
<td>Assam + Meghalaya</td>
<td>4.96</td>
<td>39.42</td>
<td>36.25</td>
</tr>
<tr>
<td>9</td>
<td>Karnataka</td>
<td>3.85</td>
<td>59.19</td>
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<tr>
<td>10</td>
<td>Tamil Nadu</td>
<td>1.69</td>
<td>52.32</td>
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<tr>
<td></td>
<td>All India</td>
<td>6.42</td>
<td>37.76</td>
<td>32.20</td>
</tr>
</tbody>
</table>

Note: The other important potato growing states of Himachal Pradesh, Maharashtra and Orissa have recorded absolute decrease in their output and the decomposition of their output gives large negative percentage.

1. There seems some mistake in &amp;#x00A0;ssix bifurcation of Punjab and Haryana data during 1960-63.
percentage contribution of yield has been low during 1960-83 and it was even negative during 1970-83. Thus, yield appears as a push factor to affect the regional concentration of potato production via the area effect especially during seventies.

To sum up, the following observations emerge from the analysis of regional distribution of Potato area and production in India:

1. The specific physio-climatic requirements for Potato cultivation seem to confine its production to the states of Uttar Pradesh, Bihar, West Bengal, Assam, Meghalaya and in specific areas of Punjab, Haryana and Himachal Pradesh.

2. The mapping of Potato growing districts indicates that the crop is more concentrated along the perennial river systems like the Indus, the Ganga and the Brahmaputra. These rivers seem to provide the best alluvial soil and may be helpful in maintaining the temperate climates.

3. Potato area is almost evenly distributed among the districts of Uttar Pradesh, Bihar and West Bengal due to similarity in their climatic conditions. However, somewhat higher contribution is made by some districts which are situated longitudinal to the sides of the Ganga and thus having relatively better soil conditions over their larger areas.

4. Over the period from 1960-63 to 1980-83, there is an indication towards increasing regional concentration of potato production among it's main cultivating states. Perhaps, the changes in
ceteris peribus conditions like technology have caused relatively higher increase in the yield level of Potato in Uttar Pradesh, Punjab and Haryana which may have been one of the causal factors in enhancing acreage under potato resulting in a gain in these states' share in the all India Potato production. While opposite has happened in the states of Bihar, Assam and Meghalaya which have also lagged in the adoption of new agricultural technology.

5. States like Punjab, Haryana and Gujarat which were having less area under potato in the initial period and have recorded higher increase in yield have also recorded higher growth rates in the acreage of this crop. The state of Uttar Pradesh which accounted for more than 1/3rd of all India area and production even before 1960-63 seems to set the trend in the national potato area and production with marginally higher growth rates during the period 1960-83. The trends in Potato acreages of All India and Uttar Pradesh exhibits similar yearly swings over the period 1958-59 to 1982-83 (figure 4.4). The position of Uttar Pradesh as a dominant producer of Potato in India has been further confirmed in recent years when its share of production has increased to 44 percent during 1980-83 and 47 percent in 1983-84. Hence, this state was selected for an in-depth analysis of dynamics of potato supply in India. Moreover, the central location of this state to the potato belt of India extending from Punjab to Assam in the North India's plains, gives a region which is relatively homogeneous
FIG 4.4 TRENDS IN POTATO ACREAGE OF UTTAR PRADESH AND ALL INDIA
in physioclimatic conditions.

Selection of such a region has also the advantage of identifying a single competitive crop for Potato. For micro-level analysis, its 26 important potato growing districts have been divided in seven sub-regions on the basis of their cropping pattern.

SECTION 'B'

A profile of the Selected Region

The socio-economic institutional conditions within which the farmers operate, affect their degree of supply responsiveness. This section, therefore, traces the important agro-economic features and other relevant informations regarding Uttar Pradesh and its 26 districts whose data has been used to estimate the supply functions of potato at micro-level too. These district have been grouped into seven sub-regions on the basis of similarity in the cropping pattern.

Region I - Mainpuri, Farrukhabad, Etawah, Kanpur, Hardoi and Lucknow
Region II - Meerut (including Ghaziabad and Bulandshahr.)
Region III - Moradabad, Rampur, Badaun, Shahjahanpur and Etah
Region IV - Faizabad, Sultanpur, Pratapgarh and Jaunpur.
Region V - Fatehpur, Allahabad, Rai-bareli and Barabanki
Region VI - Azamgarh, Ballia, Ghazipur and Varanasi
Region VII - Gorakhpur

11. B.K. Roy "An approach to Regionalization of Types of Farming in India". A paper prepared on the basis of average data of 1960-64 of all crops.
The districts included are those in which area under Potato is more than 1000 hectares and their potato acreage has exceeded one percent of the total cropped area in the concerned district in any one of the year during the seventies. The regions will be called sub-regions of Uttar Pradesh, hence forth.

Soil and topography: Uttar Pradesh lies between 25° to 31° longitudes and 77° to 84° latitudes. The potato producing regions and especially the selected districts lie in the upper and middle Ganga plains—in the doabs of Ganga-Yamuna and other tributaries of Ganga like Gomati and Ghagara (Figure 4.5). These plains have high fertility due to the presence of alluvial soil brought by the Ganga river system. The form of the soil varies from sandy loam and clay. However, the plain is broadly an area of uniform relief features carved but by the Ganga and its tributaries. The state, especially the selected districts lie in the sub-humid agricultural zone of India. The annual mean relative humidity varies from 64 to 73 in the above districts. Average annual mean temperature varies between 19°C to 20°C minimum and 31°C to 33°C maximum in this state. Normal annual rainfall received in different districts ranges from 700 millimeters to 1364 millimeters. The rainfall received increases as one moves from western part to Eastern part of the state along the Ganga. The micro-regions carved out by us seem quite homogenous from the point of view of rainfall. The fertility of soil as measured through the

12. As per the classification of Sengupta, the selected region falls in the meso region of the upper and middle ganga plains in the sub-humid agricultural zone of India. (P. Sengupta, “The Principles and Technique of Regional Planning”, The Geographer, vol. XIV, 1967.)
soil rating index does not vary much among different districts. Efforts to conserve the fertility of soil are on-going in all the selected districts. Broadly, the region has temperate climate and follows the usual monsoon seasons of India. The selected region is a densely populated area in our country. The population density of selected districts varies from 360 to 725 persons per square kilometre as compared to 377 persons in Uttar Pradesh and 216 persons in India. The local demand for Potato may be largely from the total population of the region concerned as the share of urban population is below 18 percent in most of the districts, however among these districts, Kanpur, Lucknow, Meerut, Muradabad, Rampur Allahabad and Varanasi may be having substantial demand of Urban consumers (column 2 Appendix 4.2). About 70 percent of total workers in the state are engaged in agriculture as cultivators and agricultural labourers. However, the percentage of cultivators decreases as one moves from Western part to eastern part of the state while opposite is the trend for agricultural labourers. The size of operational holdings is small with average size of 1.01 hectares in the state. More than 85 percent of the holdings are small and marginal in the state. Over the sub-regions, the average size of holding is relatively small in regions IV, VI and VII. Even the percentage of small and marginal holdings is higher in these sub-regions. It has been observed that the fragmentation of the holdings in eastern region is more than Western region. The field visit to the area revealed that potato cultivators in the western part are generally middle and rich farmers whereas in the eastern
part its cultivation is largely taken by small farmers with surplus labour power. Interestingly, the average net sown area per cultivator in regions IV, VI and VII is more than the average size of holding which indicates the presence of holding not operated by the owners themselves.

Thus, regions I to III are better placed than other sub-regions of the state from the point of view of urban demand and scale of operation. On the other hand, the percentage of agricultural labourers in the work force is more in the eastern part of the state than its western part. Some other agricultural features of the selected districts are presented in appendix table 4.3. Out of the total reported area 58 percent is under cultivation, in the state as a whole. However, the selected districts lie in the plains and their net sown area as percent of reported area ranges between 63 to 81. The land which can be brought under cultivation is less than 5 percent in the most of the districts. The weighted cropping intensity\(^\text{13}\) is 153 percent at state level and it varies from 136 to 205 percent in the selected districts. Thus, there are objective conditions for increasing cropping intensity to obtain higher income per unit of land. This scope is higher in regions I, V and IV than other regions. The main crops sown in the state are wheat, Paddy, Sugarcane, Gram and Maize which occupied about 31, 22, 7, 6 and 5 percent of gross cropped area during 1981-82. Wheat and Potato crops have become more important over the years in this state (as evident from their shares in 1966-67 and 1981-82) while

\(^{13}\) The area under Sugarcane is given double weight while calculating the gross cropped area.
the shares of gram and other pulses has decreased. Over the sub-regions, rice is less important in the lower doabs of the Ganga and Yamuna rivers, but its importance increases if one moves towards the eastern part of the state. Sugarcane and Maize are more important in regions I, II and III, in rabi-season; wheat has become almost equally important like Potato in all the selected districts and percentage of its acreage in the gross cropped area varied from 27 to 38 over the districts during 1981-82. Among other crops, the acreage under pulses is relatively less in the sub-regions I, II and III while the acreage under oilseeds is more in these regions as compared to other sub-regions. The acreage under all commercial crops as computed by Directorate of Agricultural (statistics) Uttar Pradesh (column 9 of appendix table 4.3) is 12 percent of gross cropped area in the state as a whole and the share of commercial crops is relatively higher in the sub-regions I, II and III as compared to the remaining sub-regions.

The percentage of net irrigated area to net sown area is 55.19 percent in 1981-82 at state level (column II) At micro level, sub-region II has 87 percent irrigation followed by 55, 53 and 51 percent of sub-regions III, I and VI respectively. The share of area irrigated by tubewells in the net sown area is not much different in eastern and western parts, but the number of tubewells per 100 hectares of land are relatively more in western region than the eastern region of the state. The cropping pattern of the sub-regions, discussed earlier

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seems in accordance with the irrigation and rainfall with increasing importance of the former over time. The main irrigated crops in the state are wheat, rice, sugarcane, maize, peas and potatoes. The percentage of irrigated area under wheat, sugarcane and potato out of their total area is 83, 82 and 97 percent respectively during 1981-82 and this level of their irrigation does not vary much over the sub-regions and over the years. However, the irrigation level of other crops is low and that is highly varying over the districts and over the years depending upon the rainfall. This substantiates our assumptions in Chapter III that wheat and Potato are competitive crops for irrigation and their acreages are likely to be unaffected by the variable of rainfall.

The district wise position of other agricultural and general determinants of development is represented in the appendix table 4.4. The fertilizer consumption per hectare of the gross cropped area is 57.62 kilograms in 1981-82 as compared to 31.82 kilograms in India. The average gross cultivation area per tractor is 400 hectare in this state. Over the sub-regions, the districts in Western part of the states are consuming more fertilizer per unit area and having higher level of farm mechanisation. The fertilizer sale store are almost equally distributed over the sub-regions except region III. However, the stores of government and other agencies are quite low in sub-region V as compared to other sub-regions. The credit outlets in terms of number of bank branches in proportion to the population are relatively more in districts of sub-regions I, II, III. Number of agricultural marketing centres are also relatively more in the above three regions. The
general indicators of development like per capita consumption of electricity and length of pucca road per 100 kilometers of area give highly varying picture over the districts. However, the road communication broadly indicates the better position of regions I, II and III.

The most relevant variable for the regional distribution of potato production is the capacity of cold storages. This facility is spread over all the districts, though, higher concentration seems near the urban centres like Kanpur, Lucknow, Meerut and Allahabad. Among the other districts, Farrukhabad, Mainpuri, Rampur and Varanasi are also better placed in respect of the available cold storage in the state.

\[ A_D = 50.62 + 0.34 S_c - 5.42 T_{wp} \]
\[ R^2 = 0.91 \quad F-value = 129.21 \quad d.f. = 1.69 \]

In this equation, \( A_D \) is total potato area in any of the 26 districts during 1976-78, \( S_c \) is the cold storage capacity in thousand tonnes at the end of 1980, \( T_{wp} \) is the total population plus urban population as per 1981 census. The other independent variables which did not turn out significant were gross cropped area of the district, yield of potato, well irrigated area as a percent of net irrigated area, price of the crop and fertilizer consumption per hectare. All these variables were related to the period 1978-81. The negative impact of weighted population rules out the possibility that production in this state is determined by local demand only. Perhaps the effect of some other variables like yield of the crop have been captured by cold storage variable. The cold storage capacity has correlation coefficient of 0.90 and 0.37 with potato area and its yield, respectively.
However, the total licensed capacity of 1418 thousand tonnes (5000 thousand cubit feet) at the end of 1980 in Uttar Pradesh was only 33 percent of its production in that year.

To sum up, the following broad features are reflected from the above indicators of the selected districts and sub-regions formed by grouping among them.

(i) All the selected districts are intensely populated and are situated along the basin of the gangetic system of rivers. Sub-regions I to III are more favourably placed as regards the demand from the local urban population of Meerut, Muradabad, Rampur, Kanpur and Lucknow.

(ii) The size of operational holding goes on decreasing and the percentage of agricultural labourers in the total work force goes on increasing if one moves from Western part of the state to its Eastern part along the Ganga river.

(iii) The net cultivated area is about 63 to 80 percent of the reported area in the selected districts with less than 5 percent of the reported area which can be brought under cultivation. However, the cropping intensity of the selected districts ranges between 136 to 205 percent which indicates the possibility of increasing income per unit area in some districts through the increase in the area under potato.

(iv) The net irrigated area is more than 55 percent of the net sown area and the gross irrigated area is 48 percent of the
gross cropped area. The main competing crops for irrigated area over all the selected districts are wheat, sugarcane and potato. The cropping pattern over the sub-regions seems to be influenced by the rainfall in the Kharif season while the irrigation variable may be an important variable to determine the crop pattern in the rabi season.

(v) The sub regions I to III have relatively higher level of fertilizer consumption and farm-mechanisation. These sub-regions are also ahead than the remaining sub-regions in terms of credit outlets, agricultural markets and the road communication.

(vi) The cold storage capacity licenced in the state is only 1/3rd of its level of potato production. The storage are relatively more concentrated near the urban consumption centres like Meerut, Rampur, Kanpur and Lucknow.