CHAPTER II

CLIMATE OF BUNDALKHAND

Climatic considerations in Agriculture

The fact that the most profitable type of cultivation is carried on in those regions where climate is favourable, explains in itself the dependence of agriculture, in all its phases, on the climate of the given region. There are for agriculture, 'laws of limits' and 'laws of plenty' and these are rigorously exercised by the elements of climate and weather in a cumulative manner, both directly and indirectly. Directly, the climate determines the growth or retardation of the plants. Indirectly, it provides the soils in which these plants are rooted and from which they draw all the food necessary for their sustenance. Thus climate, in its wider sense, determines the distribution of farming and restricts the choice of crops.

In regions with repressive climate, cultivation becomes well-nigh impossible, not because man cannot grow plants there but because he cannot pay such a high price for it. It is this cost factor that becomes the deciding point everywhere in the world.
But there are certain regions which are potentially very rich for cultivation but where climate is less favourable. Here man constantly struggles against the vicissitudes of weather in order to protect his crops from their wrath. Considering the miseries inflicted on man by the vagaries of climate and the resolute determination of man to fight with them, such areas have rightly been termed as 'problem areas'. Bundelkhand is a region of this type where agriculture is being practised under very uncertain and precarious conditions of weather and climate.

Let us understand fully why do we talk so much about the weather for our crops. The problem is that every plant needs a fixed quota of heat and moisture for its proper development. Any variation in these must effect them, more specially the crops that constantly need our care and attention. Man adopts, therefore, certain artificial methods such as irrigation, improvement of drainage, dissipation of fog and artificial rain, in order to defeat the game of nature.

The behaviour of the atmosphere both above and below the surface, therefore, must be understood well, so that the requirements of the 'cultured plants' may be met effectively. The underground atmosphere or the 'soil atmosphere', as it is generally called, provides necessary food
to the plant in dilute form which passes through the root system to the upper portions. The upper atmosphere is responsible for 'photosynthesis' which manufactures starch or sugar for the plant. Both are necessary for the normal growth of the plant and deficiencies of even one of them must adversely effect the plant.

The most important elements of weather and climate are: Temperature, Precipitation, Pressure, Winds, Cloudiness, and Sunshine. Let us briefly survey their influences on the plants before we discuss in general, the climate of Bundelkhand.

**Temperature**

Although different crops need different temperatures, it is widely agreed that the total range of temperature tolerable to them is about 40° F. At temperatures 40° F or below, the plant normally ceases its growth either temporarily or for ever. At temperature 100° F. or above the plant is 'baked and burnt'. Hence majority of plants need for their growth temperatures from 50° F. to 90° F. According to Thornthwaite the temperature at which the growth rate is highest is always around 30° C. or 86° F. (1)

Average diurnal, monthly or annual temperatures do not give us a fair picture of the possible effects of temperature on the growth of crops. These must be substituted by day-to-day actual temperatures for a really scientific study of plant growth. More important than the average temperatures are their frequencies, anomalies and ranges. If a temperature, say 30° F. occurs even once, the crops will be killed and harvest is gone and no heat afterwards can inject life into these delicate plants i.e. crops.

Precipitation and Humidity

Like temperature, all plants require a certain amount of water and humidity both at a given stage of growth and for the whole span of their growing period. It usually makes heavy demand of water at a time of its vigorous growth just after the seedling stage. Experiments with maize have proved that it requires 6 to 8" of rain in July and August - the period of its maximum growth, failing which its growth will be retarded, no matter in September all the required amount of rain may come. Such are the exacting limits of each plant. Whenever the rain exceeds or falls short of the requirement, the plants do not flourish and in extreme cases they may die out completely. What is true of precipitation is also true, in a limited sense, of humidity.
Cloudiness and Sunshine

Cloudiness and sunshine are the functions of temperature and humidity. Plenty of sunshine is important to all plants for the process of starch making and for killing the ordinary crop pests. When temperatures rise very high a protective cover of clouds, that normalises the temperatures and brings humidity in the air, is necessary. Prolonged cloudiness amounting to 'overcast sky' is however, harmful.

Pressure and Winds

Pressure has little effect on the crops directly, but it is great through winds. Calm cold nights often result in the occurrence of frost. Hurricane or tornado type of winds are very destructive. They uproot the plants and carry away their moisture. Light or gentle breeze is most favourable to field crops.

Analysis of Regional Weather and Climate (Plate IV)

The climate of Bundelkhand is the result of its position - astronomical or physical. The Tropic of Cancer passes just south of this region. Its situation in the interior part of the Indian sub-continent gives it a continental character with extremes of temperature and their large ranges. Centrality of the region also imposes on it the features of a transition zone between the tropical maritime climate of the east (Bay of Bengal) and the tropical
continental dry climate of the west (Thar desert). The altitude does not play an important part in determining its climate. However, the southern plateau, formed by Vindhyan Ranges has good air drainage and by virtue of that it enjoys better sensible temperatures than the northern part which is a plain.

The average annual temperatures of Bundelkhand are uniformly high (70° F. - 95° F). The mean annual temperature of Orai is 72.7° F, that of Jhansi 79.8° F, Nowgong 77.5° F, and Satna 77.1° F, but their mean monthly values considerably vary from their annual means. Their ranges are high, as the following table shows.

**TABLE III**

<table>
<thead>
<tr>
<th>Station</th>
<th>Mean monthly temperature in degrees F.</th>
<th>Range of temp. in degree F.</th>
<th>Height from Sea Level in ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>June</td>
<td>December</td>
<td></td>
</tr>
<tr>
<td>Orai</td>
<td>91.7</td>
<td>53.6</td>
<td>38.1</td>
</tr>
<tr>
<td>Banda</td>
<td>95.9</td>
<td>57.0</td>
<td>38.9</td>
</tr>
<tr>
<td>Jhansi</td>
<td>94.2</td>
<td>64.3</td>
<td>29.9</td>
</tr>
<tr>
<td>Nowgong</td>
<td>92.7</td>
<td>60.4</td>
<td>32.3</td>
</tr>
<tr>
<td>Satna</td>
<td>91.1</td>
<td>61.1</td>
<td>30.0</td>
</tr>
<tr>
<td>Average</td>
<td>93.1</td>
<td>59.3</td>
<td>33.8</td>
</tr>
</tbody>
</table>

J. P. Saxena
From the above table one can conclude that large ranges of temperature may permit diversified farming provided other elements are same. In Bundelkhand large number of crops are grown but the scarcity of water is a great hinderance. As temperatures are never below 50°F, even in the coldest month, the entire year is a growing season with a high temperature efficiency, though it is far from ideal.

This defect is noticed when we examine the maximum and minimum daily temperatures of any given year at a given place. Thus at Jhansi lowest temperature of 26°F was recorded in the month of December, 1937, which resulted in a severe frost. In the year 1964, Uttar Pradesh Government declared 3,493 villages as frost effected. (1) These were 1,019 in Jalaun, 462 in Banda, 775 in Hamirpur and 1,242 in Jhansi district. In Jalaun loss of Rabi crops was from 12% to 5%, in Banda 20% to 100%, in Hamirpur 50% to 75% and in Jhansi 10% to 25%. This shows that frost occasionally destroys large areas of standing crops in Jalaun, Hamirpur, Jhansi and Ratia. These low temperatures can not be noticed in the means and averages, but from the point of view of agriculture these are of great importance, specially their frequencies.

(1) Records of U.P. Vidhan Sabha, 1964, Section 245, no. 7 p.
The extremes of temperatures in Bundelkhand are the result of its central position as also due to heat and cold wave which often make their passage through the region in summer and winter months.

Though Bundelkhand comes under the realm of Indian monsoon, it would be improper to designate to Köpen's 'Am' to it because 'Am', strictly speaking, is found only along the coastal and hilly regions of Western Ghats and West Bengal, which face the monsoon winds. Bundelkhand represents a transitional zone between 'Am' in the east and 'BWh' in the west.

A portion, if not the whole of Bundelkhand, lies in a debatable area in the south of the 'Indo-Gangetic plain between independent fields of Arabian sea and Bay of Bengal monsoon currents. The area has been termed as a monsoon trough of low pressure and a very marked tendency exists for cyclonic storms forming in the north of the Bay, during monsoon period, to advance along this trough.(1) When this happens, heavy falls occur.

The rainfall data of about 50 stations in Bundelkhand are available from meteorological records. This has been plotted on plate V A. The mean annuals of district towns have been tabulated in Table IV which follows. (Plate V C)

<table>
<thead>
<tr>
<th>Month</th>
<th>Jalaun</th>
<th>Jhansi</th>
<th>Hamirpur</th>
<th>Banda</th>
<th>Tikamgarh</th>
<th>Chhatarpur</th>
<th>Panna</th>
<th>Datia</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>0.51</td>
<td>0.73</td>
<td>0.52</td>
<td>0.65</td>
<td>0.64</td>
<td>0.61</td>
<td>0.76</td>
<td>0.41</td>
<td>0.60</td>
</tr>
<tr>
<td>February</td>
<td>0.39</td>
<td>0.63</td>
<td>0.42</td>
<td>0.50</td>
<td>0.61</td>
<td>0.60</td>
<td>0.68</td>
<td>0.39</td>
<td>0.53</td>
</tr>
<tr>
<td>March</td>
<td>0.23</td>
<td>0.42</td>
<td>0.24</td>
<td>0.25</td>
<td>0.26</td>
<td>0.23</td>
<td>0.33</td>
<td>0.23</td>
<td>0.28</td>
</tr>
<tr>
<td>April</td>
<td>0.15</td>
<td>0.21</td>
<td>0.14</td>
<td>0.14</td>
<td>0.19</td>
<td>0.16</td>
<td>0.26</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>May</td>
<td>0.31</td>
<td>0.42</td>
<td>0.32</td>
<td>0.33</td>
<td>0.27</td>
<td>0.54</td>
<td>0.54</td>
<td>0.26</td>
<td>0.34</td>
</tr>
<tr>
<td>June</td>
<td>3.16</td>
<td>4.48</td>
<td>3.75</td>
<td>3.98</td>
<td>4.51</td>
<td>4.89</td>
<td>5.37</td>
<td>3.58</td>
<td>4.21</td>
</tr>
<tr>
<td>July</td>
<td>11.31</td>
<td>12.22</td>
<td>11.18</td>
<td>12.27</td>
<td>12.95</td>
<td>14.16</td>
<td>16.28</td>
<td>9.90</td>
<td>12.53</td>
</tr>
<tr>
<td>August</td>
<td>10.05</td>
<td>11.88</td>
<td>10.63</td>
<td>12.06</td>
<td>12.07</td>
<td>13.75</td>
<td>15.29</td>
<td>10.41</td>
<td>12.02</td>
</tr>
<tr>
<td>September</td>
<td>5.08</td>
<td>5.83</td>
<td>5.68</td>
<td>6.61</td>
<td>6.28</td>
<td>6.18</td>
<td>8.05</td>
<td>5.67</td>
<td>6.17</td>
</tr>
<tr>
<td>October</td>
<td>0.76</td>
<td>0.93</td>
<td>0.03</td>
<td>1.65</td>
<td>1.20</td>
<td>1.14</td>
<td>1.71</td>
<td>1.08</td>
<td>1.20</td>
</tr>
<tr>
<td>November</td>
<td>0.17</td>
<td>0.29</td>
<td>0.31</td>
<td>0.26</td>
<td>0.53</td>
<td>0.45</td>
<td>0.42</td>
<td>0.21</td>
<td>0.33</td>
</tr>
<tr>
<td>December</td>
<td>0.25</td>
<td>0.27</td>
<td>0.28</td>
<td>0.29</td>
<td>0.28</td>
<td>0.30</td>
<td>0.36</td>
<td>0.27</td>
<td>0.30</td>
</tr>
<tr>
<td>Total</td>
<td>31.37</td>
<td>35.73</td>
<td>34.45</td>
<td>38.93</td>
<td>39.85</td>
<td>42.79</td>
<td>50.05</td>
<td>32.55</td>
<td>38.68</td>
</tr>
</tbody>
</table>
From this table (as well as from Plate V map A) it is explicitly clear that the annual precipitation in Bundelkhand varies from 30" in the north-west to 50" in the south-east. The average may be regarded as 40" of which 35 inches or 90% comes in a concentrated manner, from June to September when the sky is often overcast and humidity is high. Rest i.e. 10% of rain, comes during the winter months from the north-east monsoons accompanied by weak depressions of foreign origin.

Like the mean annual temperature, the mean annual precipitation has many drawbacks. Agricultural geographer is more concerned with its monthly (even daily) distribution. Therefore, variability of rain, precipitation effectiveness, intensity of rainfall, actual number of rainy days, can not escape from his daily studies of climate, as applied to regional agriculture, because each one of these explains a certain aspect or behaviour of water having a direct bearing on the crops.

**Variability of Rain**

The exact degree of rainfall variability is difficult to compute, but various statistical formulae have been suggested in the form of a coefficient of variability. The most popular of these is

$$CV = \frac{U}{M} \times (100)$$
where $CV$ is co-efficient of variability, $\sigma$ Standard Deviation and $\bar{X}$, the mean value. Standard deviation is obtained from the formula

$$\sigma = \sqrt{\frac{\sum(x^n)^2}{N}}$$

where $x_n$ is deviation from mean, and $N$, the total number of observations upon which mean is calculated. Computation for a period of last 35 years \(^{(1)}\) show, the variability of rain at Jhansi, Nowgong and Satna as 20.00%, 18.83% and 17.90% respectively. It is, therefore, clear that variability of rain in respect of amount in the whole of Bundelkhand poses a great problem for the crops and extension of irrigation appears to be the only solution of these fluctuations.

**Precipitation Effectiveness**

"The effectiveness of rainfall is usually taken as the actual total of rainfall minus the total possible evaporation." \(^{(2)}\) This is expressed in terms of potential evapo-transpiration (P/E index). This is used in the calculation of moisture requirements of the soil, and in the determination of regional aridity. De-Mortonne's

---

\(^{(1)}\) Data by courtesy of A.S.Narula, Assit. Meteorologist, Director General Observations (C & G) Poona, Appendix No. 1.

JHANSI

NOWGONG

SATNA

WATER SURPLUS AND DEFICIENCY GRAPHS
Based on Thornthwaite's

Formula:

\[ P/e, 15 : t = 11.5 \left( \frac{P}{e-t} \right)^{0.5} \]

\[ P \] = Mean Monthly Precipitation
\[ e \] = Mean Monthly Temperature

---

Precipitation
Evaporation

- - - - - - - - Deficiency
- - - - - - - - - Surplus

LBS
index is

$$I = \frac{p}{t + 10}$$

where $I$ is the index of aridity, $T$, the mean annual temperature in degrees C and $P$, the mean annual rainfall in millimeters. On the other hand, C.W. Thornthwaite had made convincing use of empirical relationships between rainfall, temperature and evaporation by his well-known formula $P/E$ which is

$$i = 11.5 \cdot \frac{P}{t+10}$$

The summation of the twelve monthly values, multiplied by 10, to avoid decimals, gives the value for the year. Based on his formula, the aridity index of Bundelkhand comes to 10 meaning thereby that the climate is dry (if not very dry). The Water Surplus and Deficiency graphs, based on Thornthwaite's formula, have been drawn for Jhansi, Nowgong and Satna. (Plate No. VI) These are basically similar in nature and convince us of the general deficiency of water for crops in Bundelkhand. The graphs are self explanatory. Except for the period from July to September there is a general and wide spread deficiency of soil-moisture which becomes extremely acute during the period from April to May when the shallow wells, tanks and reservoirs dry up either completely or are greatly reduced in their supplies. Dr. Khosla reached to a general conclusion that averagely 6" of water
is evaporated from surface and sub-surface rocks each
month in drier parts of India. Thus the general aridity
of Bundelkhand, leaving wet months, is more than established.

**Intensity of Rainfall**

Intensity of rainfall determines the moisture balance
of the soil. Heavy showers, concentrated in a few hours,
not only harm the standing crops but also drain away the
water as quickly as it is received, so that little moisture
could be absorbed by the sub-soil except in those places
where it is impounded. Drizzling rain is nicely absorbed by
the soil without soil erosion. Whenever, monsoon winds are
accompanied with depressions, heavy showers are experienced
in the region. Thus at Jhansi roughly 10" of rain fell each
time on 20th July, 1927 and 12th August, 1930 and 18" at
Nowgong on 26th June, 1897 with in twelve hours.

**Rainy days (Plate V B)**

This map shows that number of rainy days in Bundelkhand
vary from 30 days in the north-west to 50 days in the south-
east. Although mere number of rainy days are not very
important (more important is actual amount of precipitation)
yet, they clearly indicate the duration of rainy season.
Thus the above map tells us that for certain crops such
as sugarcane, irrigation must be resorted to in the western
part of the region even during the monsoon season.
Characteristics of Rainfall in Bundelkhand

The outstanding characteristic of Bundelkhand rainfall is its great variability. Rainfall is exceedingly capricious both in its total amount and in its distribution in a given period. Distribution of rain over different parts of the region has been shown by isohytes (Plate V Map No. A). These vagaries of rainfall have caused enormous loss of life and property in the past. Floods and famines have been the lot of the people for centuries. Following instances may serve to emphasize the nature of monsoon in the region:

1. The monsoons may be delayed considerably. In the year 1965-66, no rain fell during June, July and August except the initial showers on 3rd July. In the year 1837-38 and 1877-78 monsoon was late by two months and no rain fell in Banda, Hamipur and Jalaun.

2. The monsoon may break in time but may cease prematurely as it happened in 1907-08 when monsoon started on 20th July (late by one month) but stopped on 27th August. This means that monsoon may start late and cease early.

3. Long dry spells are often experienced during the rainy season. In the year 1868-69 owing to this phenomenon Kharif crop completely dried out in Jalaun pargana and resowing could not be done. This resulted in a famine then.
4. The total precipitation may be extremely variable. It may be excessive, low or just normal. Monthly falls are equally variable. The year 1905-06 proved to be the driest year for the region as a whole. In Mau (Banda) only 11" rain fell against its normal of 40" and the whole region was gripped by a severe drought. On the other hand, 1867-68 and 1864-65 were wettest. In the year 1871-72 Mau received twice as much rain as its average.

A special feature was observed in the year 1860-61 when the total precipitation was only 16" as against the regional average of 38" but the rain was so well distributed that the harvest was reported as 'good'. It had been recorded as the year of prosperity. The same feature was repeated in 1870-71.

5. Winter rain called 'Mahot' is also very uncertain. If timely and in required amount, its effects are considerably good on the rabi crops.

6. Local storms, particularly in the months of March and April, are usually accompanied with heavy showers and hail, hence very destructive to the harvest. In the year 1939, as per record, the rabi crop of about 26 villages in Jalaun district was completely damaged by the hailstorm. Less intense type of local storms are more numerous and occur almost every year.
7. Cyclonic rain comes in heavy showers. If the cyclone is of weak type it may drizzle for days together.

For the region as a whole a tendency has been observed over a series of years. Periods of excessive, and insufficient rainfall alternate. These occur in a fairly well-defined successions in northern districts of Jalaun, Hamirpur and Banda. Thus in Banda from 1871 to 1876 the rainfall was normal while from 1877 to 1881 it was deficient and severe droughts and famines took place. These years were followed by excessive falls from 1882 to 1890. Normal years supervened to culminate in the deluge of 1894-95 which was in turn followed by disastrous droughts. Since 1899 seasons have been on the whole normal but deficiency was again felt from 1905-1907. (1)

**Seasonal Rhythm in Bundelkhand**

There are three well marked seasons in Bundelkhand:

1. Hot and dry summer season from 15th March to 15th June.

2. Rainy season from 15th June to 31st October.

3. Winter season from 1st November to 15th March.

---

(1) Summer-season Conditions

By 15th of March the winters are over. Days start registering higher temperatures day by day, although nights still remain cold. April distinctly becomes a warm month. The sun shines brightly overhead; sky becomes clear and atmospheric humidity is at its lowest. The change from winter to summer is incredibly quick.

The mean seasonal temperatures range from 88° F. to 96° F., but actual temperatures are higher and changes in them are so quick that within 15 days temperatures increase by 10 deg. F. The quick changes in temperature retard the normal development of grain in the crops.

The early part of the summer, though hot, is not intolerable, but as the season advances heat becomes more and more oppressive and open field work becomes impracticable. Temperatures, during the day often cross 100° F. and then start the hot scorching winds called 'Loo'. May and June are hottest months and shade temperatures up to 117° F. (1922) and 118° F. (1924) have been recorded in these months. Nights are also hot with temperatures seldom below 60° F. In the southern plateau region, owing to the local height, forest cover and undulating topography, good air-drainage is maintained, specially during the nights.
55.

Pleasant nights of Lalitpur have become proverbial. As a whole the Vindhyan Plateau is 5° to 7° F. cooler than the Northern Plain.

May and June are also the months of frequent dust-storms, partly of local and partly of extra-regional origin, i.e. from western Uttar Pradesh and eastern Rajasthan. Large amount of yellow dust is blown up into the sky. This gives to it a dull or hazy appearance except in Banda district where sky remains remarkably clear due to (i) 'exhalation' of moisture from the fissures of black soils (ii) heavy nature of these soils, which are not easily lifted up and (iii) greater distance from the sources of these storms. So, much of the dust settles down before it reaches Banda district and further east. The unique character of this phenomena is chiefly responsible for a very large number of deaths caused by sun-strokes.

The pressure over Bundelkhand and area around it is about 29.50". The isobars are far spaced from each other so that winds are weak, almost calm and these prevail for days together, only broken by duststorms mentioned above.

Summer season is the period of least relative humidity which varies from 30% to 40%. The average relative humidity of April is only 24.3%. Humidity, however, increases in the month of June when easterly winds start moving and bring...
with them atmospheric humidity from the Bay of Bengal.

The month-wise relative humidity of three meteorological stations, Satna (east), Nowgong (centre) and Jhansi (west) has been tabulated below to show that 70 to 80% of relative humidity coincides with the period of monsoon rains. From October to February it is 50 to 56% and from March to June 25 to 50%.

**Table V**

**Percentages of mean monthly Relative Humidity in Bundelkhand**

<table>
<thead>
<tr>
<th>Months</th>
<th>Jhansi (West) %</th>
<th>Nowgong (Centre) %</th>
<th>Satna (East) %</th>
<th>Average %</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>75.0</td>
<td>73.0</td>
<td>79.0</td>
<td>77.3</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>77.5</td>
<td>85.5</td>
<td>82.5</td>
<td>81.8</td>
<td>72 - 80</td>
</tr>
<tr>
<td>September</td>
<td>68.0</td>
<td>73.5</td>
<td>75.5</td>
<td>72.3</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>45.0</td>
<td>53.0</td>
<td>60.5</td>
<td>52.8</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>41.0</td>
<td>57.0</td>
<td>53.5</td>
<td>50.5</td>
<td>47 - 56</td>
</tr>
<tr>
<td>December</td>
<td>47.5</td>
<td>58.3</td>
<td>55.0</td>
<td>53.0</td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>48.0</td>
<td>67.0</td>
<td>55.0</td>
<td>56.0</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>42.0</td>
<td>51.5</td>
<td>49.0</td>
<td>47.5</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>26.5</td>
<td>36.5</td>
<td>32.5</td>
<td>31.8</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>20.5</td>
<td>30.0</td>
<td>22.5</td>
<td>24.3</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>22.5</td>
<td>31.0</td>
<td>26.0</td>
<td>26.5</td>
<td>24 - 51</td>
</tr>
<tr>
<td>June</td>
<td>47.0</td>
<td>56.0</td>
<td>52.5</td>
<td>51.8</td>
<td></td>
</tr>
</tbody>
</table>
Rainfall during the pre-monsoon period is local and sporadic. It usually comes in short light showers from clouds which are formed by local heating of the atmosphere. Their frequency increases as the monsoon period approaches.

Since after the period of harvest in March/April, a period of agricultural non-activity starts (with rare exceptions of those isolated spots where plentiful irrigation is available from canals) the peasants devote most of their time in threshing and cleaning the grains. Rest of the time is spent in making social contacts and participating in marriage parties. With the early showers of mid June, however, intense farm activity begins and farmers, all over Bundelkhand, are seen manuring, ploughing and sowing their fields with which the entire agricultural landscape changes.

(2) **Rainy Season**

By June 21st the Sun is vertical over the Tropic of Cancer, which passes just south of Bundelkhand. The temperatures shoot up to 110°F. (actual). The entire region becomes abnormally hot. This creates a field of low pressure in the north-western part of India. It goes on intensifying till the second week of June when the monsoons normally reach and break in the region.

The advent of monsoon winds immediately reduces the regional temperatures by 8° to 10°, by which a sense of general
relief is felt all over the region. But temperatures during the day continue to be high enough i.e. above 80° or 85° F. The typical weather becomes muggy or sultry (R.H. 70 to 80 percent) and is very discomforting to man.

The nature and characteristics of rainfall in Bundelkhand need not be repeated here but from the distribution map of rainfall (Plate V map a) it may be seen that it is very unevenly distributed. Generally speaking rainfall decreases from east to west or, more correctly from southeast to north-west. This is an unmistakable proof of the fact that the region is largely influenced by Bay of Bengal current. However, it may be possible for the Arabian branch to penetrate the area during the 'break' periods to give some rain in the southern part of the region.

During the period of rainy season, from 15th June to 15th October, roughly 36" of rain falls in the region (annual average 40") i.e. 90% of the annual precipitation takes place in these four months. Monthly averages are so variable that none can predict the sowing time correctly. The first few light showers are mostly misleading. Some farmers may sow their fields early ('Agmania') but others may do it late ('Pichhmania') and it remains always uncertain as to which of these sowings would bring the best results. There is much left for chance despite certain customary calculations.
If the crops are destroyed by drought or floods resowing is done under favourable weather conditions only.

The greatest harm to crops is often reported from 'cloud-bursts'. These are generally associated with tropical cyclones. Following table suggests that unusually heavy precipitation took place several times in the past within 24 hours at certain places.

**TABLE VI**

<table>
<thead>
<tr>
<th>Stations</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jhansi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly average</td>
<td>4.17&quot;</td>
<td>11.81&quot;</td>
<td>11.59&quot;</td>
<td>5.70&quot;</td>
</tr>
<tr>
<td>Ht. in 24 hours</td>
<td>5.52&quot;</td>
<td>9.43&quot;</td>
<td>13.81&quot;</td>
<td>10.30&quot;</td>
</tr>
<tr>
<td>Nowgong</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly average</td>
<td>5.44&quot;</td>
<td>13.81&quot;</td>
<td>13.09&quot;</td>
<td>5.81&quot;</td>
</tr>
<tr>
<td>Ht. in 24 hours</td>
<td>18.22&quot;</td>
<td>9.16&quot;</td>
<td>9.74&quot;</td>
<td>6.66&quot;</td>
</tr>
<tr>
<td>Satna</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly average</td>
<td>5.54&quot;</td>
<td>14.25&quot;</td>
<td>13.20&quot;</td>
<td>6.89&quot;</td>
</tr>
<tr>
<td>Ht. in 24 hours</td>
<td>22.15&quot;</td>
<td>8.25&quot;</td>
<td>11.80&quot;</td>
<td>6.05&quot;</td>
</tr>
</tbody>
</table>

This table clearly points out that in extreme cases, more rain may fall in 24 hours than the total mean for that month.

(1) Mem. of I.M. Deptt. Vol. XXVII Part V
Pressure, throughout the rainy season remains low and with it the direction of winds remains easterly called 'purvia' (though they are called south-western monsoon winds). These bring moisture and rain. Their intensity is, however, reduced when the rainy season approaches its end. October and November are the months of retreating monsoons so that in October only sporadic rain falls from the cumulus or cumulonimbus clouds formed usually by local heating. These are easily formed as sufficient humidity remains in the atmosphere. These 'cloud bursts' are local and temporal in character and soon after the rain, weather becomes clear. By the end of October this phenomenon ends and with it the rainy season is also over.

(3) Winter Season

From October onward, as the sun marches on its southward journey, temperatures in the Northern Hemisphere gradually decrease and low pressure in north-western part of India is slowly replaced by the high pressure. November represents a transitional month when the hot-wet weather changes into cold and dry weather. It is a month with warm to hot days and moderate to cool nights. From December the real cold weather starts.

On the whole, the winters are pleasant because of dry and cool (occasionally cold) winds from north-west, where
high pressure is formed and which goes on intensifying there. Average winter temperature of Bundelkhand may vary from 60°F to 75°F. Southern high lands are decidedly cooler. Lalitpur is just 5°F less than Jhansi. As a result of this, Lalitpur often suffers from severe frosts that occur during calm, cold and cloudless nights. But these may occur in any part of the area and may destroy the rabi crops. In most cases the frosts are associated with the cold winds which develop over the snowly Himalayas and slip downward into the valleys to make their passage through the northern plain. Jhansi and Nowgong have also recorded certain very severe types of frost. (1)

From the point of view of precipitation and humidity winters are marked by scanty rainfall and low relative humidity. Nevertheless, two to three inches of winter rain occurs every year and proves very useful for the crops. This protects the standing crops from water starvation and saves huge sums of money of the peasants on irrigation. Winter rain chiefly comes from extra-tropical cyclones that find a trough of low pressure for their passage and give scanty but widespread rain throughout northern India. These, however, hardly go south of Narmada valley.

(1) Jhansi 26°F (Dec. 1937), 32°F (Feb. 1929), Nowgong 32°F (Dec. 1926), 29°F (Jan. 1935). Year 1960-61 was the severest for Bundelkhand and 108 villages were declared by U.P. Govt. as revenue free because harvest was totally destroyed by frosts.
Cyclonic rain temporarily increases the humidity of the atmosphere so that fogs of varying density occur in the early hours of the morning. Though usually short-lived, they may some times, continue to persist up to 11 A.M. These keep wheat fields cool and moist.

At the end of March or the beginning of April, cold weather gradually becomes warmer before hot and dry weather finally sets in. Pressure adjustments again take place. These changes are symbolised by the storms. They are usually very harmful as they bring with them heavy showers of hail so that crops are badly damaged or destroyed by them.

During the winter months the peasants are working very hard in irrigating their crops, weeding out unwanted grasses and safeguarding their harvests from pests, birds, wild beasts and domesticated animals. Usually the farmer lives on his field in a raised thatched hut ('Machan') and keeps a constant vigil by throwing stones at the flocks of birds or by beating drums to keep away the beasts such as wild boar, rabbits, deer etc. Wild beasts move out in the night and ravage the crops. In the areas where sugarcane is grown, farmers are busy in crushing it and in making 'gur' from it.
CONCLUSION

With an average annual temperature about 70 F., the climate of Bundelkhand appears to be favourable for production of crops all the year round. It is, however, not the whole truth, because Bundelkhand suffers too much from extremes of temperature. Temperatures above 100 F. (critical for cultivated plants) are usually experienced over a long period from May to June. Likewise in January and February frosts of varying intensity damage rabi crops. Besides, the uncertainty of rainfall, both in time and amount, remains to be the most important factor controlling agricultural operations in the region. The region suffers from very low to very high amount of precipitation with the result that the farmers are forced to adopt or introduce several type of adjustments almost every year such as early sowing, late sowing and resowing of their fields. This results in great wastage of time, money and labour and the results of which are not necessarily duly rewarded. Past records show that standing harvests were completely destroyed by untimely hail or rain from time to time in different parts of Bundelkhand. Agricultural pests such as 'rust' and weeds like 'kans', which are the direct consequence of certain elements of weather, also play havoc with the regional crops. These characteristics of the region, discouraging as they are, should not necessarily cast gloomy prospects.
for future development of agriculture in Bundelkhand. If facilities of adequate irrigation and soil conservation are developed, much of the effects of uncertain and inadequate rain may be mitigated.