Chapter I

PHYSICAL SETTING

Section A : Physiography & Soils

Situation

The Moradabad district lies in the North Western Uttar Pradesh. It is a fairly compact district, bounded by the parallels of 28° 20' N. and 29° 16' North latitude and the meridians of 78° 4' E. and 79° 6' East longitude. The Ganga river borders it on the south-west while the Himalayan foot hills approach it on the north-east in the Nainital district (Figs. 16A & 68). For administration the district has been divided into six tahsils - from east to west - Thakurdwara, Moradabad, Bilari, Sambhal, Amroha and Hasanpur* (Fig. 1).

The present district boundary was, more or less, finally settled in 1870 A.D.* Minor adjustments took place recently with the integration of States after Independence, e.g., the newly

* Unlike some other parts of the country, the tahsils in this district are the same as the revenue parganas.

created district of Rampur got a few villages of Moradabad tahsil, lying to the east of the Bahalla Nadi.

**Area**

The present area of the district is about 2,293.3 square miles**. It is apt to vary from time to time, owing to the shifting action of the rivers, particularly the Ganga river along which a deep stream rule prevails†.

* List of villages transferred to Rampur District is as under:

1. Darhi Darhial
2. Lodhipur Naik
3. Darhial Mustehkam
4. Darhial Ahtmali
5. Pipli Naik
6. Chandupura Sikampur
7. Ratua Nagla
8. Rannaghar Latifpur
9. Lakham Nagla
10. Chak Rafatpur
11. Khasha Khera
12. Rakha Nagla
13. Kar Khera
15. Kasia Kunda

** Area by tahsils is as under: (Acres)**

<table>
<thead>
<tr>
<th>Tahsils</th>
<th>Year 1881</th>
<th>1904-05</th>
<th>1957-58</th>
<th>Difference from 1904-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amroha</td>
<td>245,308</td>
<td>2,45,499</td>
<td>2,45,673</td>
<td>+ 74</td>
</tr>
<tr>
<td>Bilari</td>
<td>213,085</td>
<td>2,13,085</td>
<td>2,13,085</td>
<td>+ 27</td>
</tr>
<tr>
<td>Hasanpur</td>
<td>349,434</td>
<td>3,54,035</td>
<td>3,54,450</td>
<td>+ 10,396</td>
</tr>
<tr>
<td>Moradabad</td>
<td>199,213</td>
<td>1,90,812</td>
<td>1,90,812</td>
<td>0</td>
</tr>
<tr>
<td>Sambhal</td>
<td>299,236</td>
<td>3,00,050</td>
<td>3,00,050</td>
<td>+ 11</td>
</tr>
<tr>
<td>Thakurdwara</td>
<td>152,320</td>
<td>1,53,736</td>
<td>1,53,736</td>
<td>0</td>
</tr>
<tr>
<td>Total Distt.</td>
<td>1,469,560</td>
<td>1,469,721</td>
<td>1,469,721</td>
<td>+ 141</td>
</tr>
</tbody>
</table>

RELIEF

(Adapted from Survey of India One Inch Map)

FIG. 2
Hasanpur tahsil has gained much in area since the beginning of this century. It owes to the fact that on the whole, the Ganga river has shifted towards the west. Moradabad tahsil has lost much in area, recently, owing to the transfer of some villages to Rampur as noted above. Elsewhere only minor changes have taken place in the tahsil areas.

**Surface Features**

The district forms a part of the Ganga plain, which is composed of the sediments deposited by the rivers in the depression lying in front of the Himalayas. These deposits are generally divided into two horizons, viz.

1) The Older Alluvium comprising the ground above the present flood-level of the rivers. It is also called ' Bangar '.

2) The Newer Alluvium comprising the present flood plains. It is also known as ' Khadar '.

The Khadars are, usually, divisible into two levels, namely,

(a) The lower level, flooded by normal floods. Locally, it is called ' Ahtwali ' Khadar.

(b) The upper level, inundated only by very high floods. Locally, it is called ' Mustakan ' Khadar.

A reference to the relief map (Fig. 2) shows


xx Locally it is pronounced as ' bangar', but some writers have written as ' bangar'.

-3-
I. The Arable Upland

II. The Bhurland

III. An Adhek village
that the difference in elevations in various parts of the district is not great*. The maximum height is in the north-east and north and the minimum in the south and south-east, so that there is a general slope from the north-west to the south-east. The average slope from north to south, in the eastern sections, is about 3 feet per mile; that from west to east, in the middle section, is about 2 feet per mile.

In the west, sandy accumulations known as 'bhur ridges' occur**. These sand dunes vary from 5 to 35 feet in height above their base. Probably, they have been formed where there were obstacles to wind-movement, e.g., clumps of trees or shrubs*. Probably, they represent the ancient sand deposits laid down by the Ganga river when it flowed at the level of the present bangar uplands. Much of the river deposits in this part of the Ganga valley comprise sands and, when the rivers change their courses or when the down cutting is greater, these deposits are left at higher levels. Even high floods, 

* This map has been prepared by interpolating approximate contour lines between the spot heights shown on the survey of India's one-inch maps for the district, published between 1912 and 1943 A.D.
** Plate I shows the general landscape of the bangar uplands. Plate II depicts the topography of the bhurland.
sometimes, throw up sand deposits at higher levels. 
Thus Birupur Baryar, a village in the valley of the 
Ramganga, has been laid waste by a cover of sand 
deposited by the river in 1955 A.D.

The rivers, streams and nullahs are more 
important architects of surface features in this lowland 
area. The Ganga and the Ramganga rivers have developed 
wide Khadars. The gullying effect of tributary 
streams has, in places, rendered the topography 
undulating, more particularly in the north-eastern 
tract of the Thakurdwara tahsil. The difference in 
level between the river channels and banger uplands 
varies, generally, from 5 to 20 feet. In places, the 
banger or bhurlands form cliffs above the river 
channels but elsewhere they descend into the Khadars 
more gradually as shown by Fig. 3. The 'adhek' or 
scarp villages* in such situations have three types 
of ground or three 'haris', viz. (a) the upland har, 
(b) the slope har and (c) the khadar har. Chaki Khera 
on the Bagad Nadi and Pahladpur on the Jot Nadi re-
present such villages. Within the banger and bhurlands, 
both the erosional and depositional factors have 
combined their effects to create some minor undulations 
and shallow depressions as can be seen from Fig. 4.

* Plate III shows the topography of an adhek village.
SAMPLES OF PHYSIOGRAPHIC & SOIL VARIATIONS

LATIFPUR

CHAKI KHEDI

SAHIBPUR

MACHHARYA

SAHIBPUR

PAHLADPUR

TIKHUNTI

RAMNAWALA

KHAIQPUR KALAN

FIG. 4
To apply the words of C.H.K. Spate, in the featureless alluvial expanses there are "micro-regional differences of slope and aspect, in some areas undulations faintly perceptible to the eye. These are tracts or facets rather than sub-regions, though they may be associated with soil or water table variations by no means without agricultural significance".

**Water Table.**

The water table varies from 2 to 5 feet in the lowlying Khadars, to about 25 feet in the Gangan - Ban doab and Thakurdwara uplands. The influence of slope on the water table is made conspicuous in 'achek' villages as Chaki Khera and Pahladpur.

Boring experiments carried out in the western and northern parts of the district have shown that the permanent spring level is quite deep**. In parts of Hassanpur this seems to be as deep as 80 to 90 feet but, elsewhere, it is found within 40 feet below ground level.

Speaking about the hydraulic conditions in the Ganga Khadar tract of the district, D.M. Sweton

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has stated* that "the water level in the bhur tract is low; its locus is probably about the point where the bhur commences its sudden descent into the jhil. Its moisture in the rainy season, descending rapidly to the channel of the jhil and there meeting the river surplus, forces its way through a natural syphon below the alluvial bangar, deposits its detritus as an increment to the bangar, and meets the volume of river moisture just where the khadar plain clearly begins."

The water-table conforms to the surface topography curving up under the mounds and becoming flat under the plains. It sinks low near the river banks and at a change of slope in order to avoid losing water along the slope by seepage, capillary action or evaporation.

The factors governing the supply of underground water are as follows:

1. Porous alluvium of the Ganga Plain as shown by tube well borings (Fig.5).
2. Percolation/rainwater, depending on the nature and amount of local rainfall.

3. Slow seepage from the streams, canals and other water bodies.
4. Seepage from the irrigated fields.
5. Slow seepage from the terai area.
6. Slow seepage from the northern mountains, where the rainfall is heavier.

Moradabad district comprises a part of the Gangetic alluvial system, which, east of the submerged extension of the Aravallis from Delhi towards Dehradun, occurs in a single basin. Continuity of the alluvium in this basin permits the greater rainfall supply of the terai belt being operative as a means of replenishment in the area to the south. There is, therefore, no question of the lowering of water-table and drying up of the wells here.

**Drainage.**

Figure 6* shows the drainage pattern of the district. It clearly indicates:

(a) that the central uplands serve as a main water-divide between the Ramganga valley in the east and the Ganga valley in the west;

(b) that the Ramganga is a more important line of drainage in the district;

*This map has been adapted from the Survey of India 1/4 inch sheet Nos. 53K and 53L.*
(e) that the north-eastern and western sections of the district have a greater drainage density than the central section;

(d) The north-central part of the central upland is rather poorly drained.

The rivers of the district may be classified as under:

(i) The Himalayan Rivers comprising the Ganga and the Ramganga.

(ii) The rivers of the plains comprising the tributaries of (i), e.g., the Dhela, the Kosi, the Gangan, the Ari, the Sot, the eastern Bagad and the western Bagad.

while the Himalayan rivers carry some water throughout the year, most of their tributaries dry up in the dry season; only the larger ones such as the Gangan and the Sot retain a little water throughout the year. The variation in the discharge of the Ramganga is enormous*. During the dry season it becomes a narrow and fordable stream. During the rainy season, however, all rivers rise enormously and flood the surrounding countryside. Fig.7 shows the areas suffering from floods at shorter and longer intervals.

Plates IV-V.

IV. Ramganga in spate

V. Ramganga in dry season
All the rivers are meandering and widening their valleys so that undercutting of banks and forming of cliffs is common. The khadar areas are covered in alternate years by silt and sand. Much soil erosion is carried on by the tributary streams also and many of them are flowing in relatively deep and narrow valleys. Fig. 8 shows the lower Sot valley with gullied and steep sided banks.

The drainage of the north-central uplands and western bhurlands is, however, defective to a degree. Between the Hasanpur bhur and the central Amroha bhur, where the Sot nadi takes its rise, there rain-water collects, first, in a shallow sheet of water and then in broken and irregular ponds locally known as ' dehrs '. From the bhurland it flows down in shallow seasonal streamlets called 'chhoivas', which have tortuous courses due to the criss-cross layout of the sand dunes.

This poor drainage is further associated with a phenomenon, locally known as 'udla or choya'. The 'udla' tract lies to the east of the Hasanpur bhur where the rain water soaks. Then, the water

* Plates IV, V show the Ramganga in flood and dry conditions. Plates VI to VIII show samples of eroded lands.
VI. Debris on the bank of the Karula Nullah

VII. Ramganga has denuded its bank

VIII. Eulied bank of the Gangan Radi
oozes out at the base of the bhur and in the low lying areas to the east of that.

In the south-east of the Amroha tahsil also the flood waters from the northern and central Amroha have created a 'panmara' or water-affected tract.

The defective drainage of the area is partly due to the construction of east-west roads and railways without sufficient culverts under them. The rail tracks are built high and strongly enough to withstand rainwash from the countryside. They act as dams obstructing the normal flow of water so that many acres of land are temporarily submerged on their uphill side as shown by Fig. 9. Sometimes, the outflowing water may scour the foundations of a narrow bridge and result in its crash*. Frequently a great loss is done to both crops and property in the submerged villages. Kharif crops are almost destroyed, while the sowing of rabi is greatly delayed.

* On the 25th June, 1921, the railway bridge over the Sot Nadi collapsed and the Delhi passenger train crashed through the tottering bridge into the flood. The road bridge, a few miles down stream, was also carried away, vide, Distt. Gazetteers of the U.P., Supplementary Notes and Statistics, Vol. XIII, Moradabad District, 1928, p.2.
PART OF UPLAND WITH DRAINAGE DEFECT

FIG. 9
There are various remarks in the district Gazetteers about the evil effects of the floods resulting from the defective layout of these tracks.

In 1922, floods again occurred, but though Amroha itself was 4 feet under water, the temporary bridge on the Sot withstood all attacks. Near Moradabad, the Kashipur branch of the Rohilkhand and Kumaun railway was breached, while spinning and weaving mills siding was washed away.

Very heavy rainfall was recorded in the Moradabad district during the 72 hours ending at 8 A.M. on 29th Sept., 1924. The rivers Ramganga and Dhela overflowed their banks and uniting together overflowed the entire area between Moradabad and Kashipur railway line. The flood exceeded all previous records by 20 inches. The Ramganga river flooded a large area in the neighbourhood, destroyed 33 villages and the old Shahi bridge at Rajhera, and finally joined up with Rajhera river and the Kosi.

The railway line between Moradabad and Bareilly was breached in several places, the most serious breach being just beyond the Ramganga bridge. The line to Delhi was also very badly breached, in particular near Kankather station. The Rohilkhand and Kumaun railway line between the left bank of Ramganga and Got railway station had been washed away. (Distt. Gazetteers of U.P., Supplementary Notes and Statistics, Vol. XVI D, Alld, 1934, pp. 1-2).

The villages lying between the Ramganga river and the line of the Rohilkhand and Kumaun Railway, that runs from Moradabad to Kashipur have suffered in recent years from floods from the Dhela river owing to the want of adequate waterways along the railway line. This railway line was opened in 1908. Even before that the Dhela Nadi when in flood would put the country between it and the Rajhera Nala and Ramganga under water; but the depth would be only a foot or two and the duration of the flooding would be a question of an hour or so only. The interposition of a long continuous solid embankment by the railway, however, has radically changed the situation. (Distt. Gazetteers of U.P., Supplementary Notes and Statistics, Vol. XVI, Moradabad, 1914, pp. 1-2).
CHANGES IN RIVER COURSES

UPPER GANGA - KANKATHA

UPPER RAMGANGA - BISOPUR

LOWER RAMGANGA

LOWER GANGA

FIG. 10
Changes in the River Courses

Both the Ganga and the Ramganga meander through wide khadars and change their courses frequently as may be seen from Fig. 10. The long line of swamps at the base of the Hasanpur bhum, now occupied by the Bagad Nadi, seems to mark some older course of the Ganga river, when it cut off the Bagad upland from the Central Bangar of the district. The Katwali and the Bala nadis mark some more of its older courses through the khadar. Similarly the Hurhi Ramganga nullah near Daulat Bagh or Bangla gaon marks an older course of the Ramganga which has shifted a little eastward in the recent years.

In the latter part of the 19th century, the Ganga took an easterly turn near Biharipur, in its southern section, till it was checked by the Bagad bangar, a tract of higher ground between the eastern

*These maps have been prepared as under:—

a) The courses of the rivers for the years 1911-12 are based on the Survey of India one inch sheets surveyed in those years.


c) Those for the year 1900-01 are based on the tahsil maps published by the Board of Revenue, N.W.P. and Cudh.

d) Those for the year 1871-73, 1909-10 and 1940-41 have been plotted field to field in respective villages basing on the account of the Settlement Volumes of those years and then reducing the maps.

e) Those for the year 1955-56 are based on corrected tahsil maps available with the Registrar zamungs and on personal observations.
Bagad and the western Bagad. It, then, cut a deep channel into the Kahawa Nadi or the western Bagad and another into the low ground between Mirpur Dhabke and Purara*. These channels were silted later on. But, during high floods the river has always been inclined to take up an easterly course**.

In the northern section, the Ganga river turned east in the year 1955, when Tigri was in great danger and the river occupied a channel for two miles along the railway line between Kankather Railway station and the Ganga bridge, but the river again shifted to its earlier channel.

The Banganga has inclined to the west in its northern section, and has washed away some villages like Rajupur khadar and Bhankri. Further downward its recent inclination is towards the east and Daulat Bagh has experienced a great change in its lot as shown in Fig.112.

** The effects of the destructive floods caused by the spill into the Kahawa river are more noticeable in Budaun district. But, there is a danger that the main stream of the Ganga may break its way into the Mahawa, thus rendering useless the great headworks of the lower Ganges canal at Narora. Fearing this, efforts have been made from time to time to check the easterly tendency of the Ganga. But, the erection of protective embankments has resulted in the shifting of the danger point further south so that the river has destroyed most of the Sirsa village. Vide Nevill, H.R., Op.cit., p.p.7-8.
South of the Kathghar bridge the Ramganga took a westerly course in the year 1935, when it washed away Rustampur Budhmar (Fig. 10D) and laid waste most of Birpur Baryar (Fig. 11A).

Even the small streams change their courses much, as can be seen in the case of the Ganga Nadi in village Machharya (Fig. 11D).

Owing to these changes in the courses of the rivers and streams, the lot of the relatively lowlying khadar villages is frequently changing. Sometimes, even the higher khadar villages are affected as has happened with Birpur Baryar (Fig. 11A). The 'adhak' or scarp villages are always in a risk to be undercut and swept away when the meandering current of the rivers comes to strike against them.

The change in the lot of village Daulat Bagh (Fig. 11B) between the years 1871-72 and 1909-10 seems to have been associated with the high flood of 1897 A.D. and an easterly trend in the course of the Ramganga at that time.

The change in the lot of Matena (Ganga khadar) has been positive. The very name of Matena New Mustehkam suggests that the village has become New Mustehkam. The change in the lot of Matena has been positive. The very name of Matena New Mustehkam suggests that the village has become

*Maps in Fig. 11 have been originally prepared by inserting the field to field accounts of the village land use mentioned in the Settlement Volumes of the respective years into the village maps appended to those volumes. The field to field information of the latest year along with the latest maps have been obtained from the Lekhpal with whom the latest field outline maps were also available.
stable comparatively recently owing to the westward shift of the Matwali Nadi in this part of its channel. At some older stage the stream flowed across the 'Jhab' making its deserted course and lying across Matema Old (Fig. 11C).

Jhils

In addition to the long chain of the Ganga khadar swamps lying at the foot of the Hasanpur hill, there are some small depressions or ponds found in various parts of the district and locally known as Jhils. In the east of the Moradabad tahsil, there is the Chandi Jhil near Sihal and the Nama Jhil at Siraskhera. To the west of Moradabad town there is a chain of ponds near the source of the second Karula nullah. These are very shallow and usually dry up during the winter season. To the south of Amroha town there is the jhil of Purampur and in the west near the source of the Sot nadi there is the jhil of Chandpur and some others as well. But the jhil of Kanth in the Ramganga khadar is much bigger than these jhils and is supposed to be an old ox-bow lake of that stream. There are a few jhils in the north-east of Sambhal tahsil also, e.g., near Qumsani, Saindri, Sirsi and Rahtaul. But, in Bilari, jhils are somewhat more numerous though they contain seldom more than a few inches of water. To the east
of Mahmud Muafi there is a series of such jhils. Near Pipli on the eastern border again there are some jhils. A large depression exists at Bania Khera to the south of Aкраuli, while Bilari town, itself, is bound on its south by a small depression. Amroha town, is almost wholly surrounded by a number of small ponds. In Sambhal town this pattern is repeated.

SOILS

The soils of the area are transported - alluvial and wind-borne - loams, silts, clays and sands. The main difference between one soil and the other lies in the advantageous size of the particles. Variations in soil fertility are mainly due to the moisture content and the percentage of calcareous or saline matter in the soil. The land revenue soil demarcation, in 1904-05 4.1% recorded in the district 67.81% loam (dumat), 11.83% clay (matiyar), 20.22% sand (bhur) and 0.04% gauhan (especially rich soil near the village site). The soil demarcation of 1939-41 4.1%, employed 17 subdivisions of these soils, basing them on soil texture, moisture,

** Singh, J.K., Assessment report of Tahsil Moradabad (1942) p.6-8.
irrigability, distance from the village site and intensity of manuring, etc. Fig. 12 presents a generalised distribution of soils in the district basing on these demarcations since the exhaustive scientific knowledge of the soils of the district is lacking. Fig. 4 shows some samples of the soil variations found in the villages.

* The map has been prepared by plotting the generalised soil classification of the revenue assessment circles on the one inch to one mile map and reducing the same.

** The result of chemical analysis of a local soil sample by Prof. Ved Prakash, Head of Chemistry Dept. of Hindu College, Moradabad, is given below. The sample was taken from a field adjoining the College.

<table>
<thead>
<tr>
<th>Component</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignition value</td>
<td>4.518%</td>
</tr>
<tr>
<td>Sesquioxides</td>
<td>7.104%</td>
</tr>
<tr>
<td>Calcium oxide</td>
<td>2.043%</td>
</tr>
<tr>
<td>Phosphorus pentoxide</td>
<td>0.414%</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.733%</td>
</tr>
<tr>
<td>Insoluble portion (silica)</td>
<td>75.880%</td>
</tr>
<tr>
<td>Ferric oxide</td>
<td>1.722%</td>
</tr>
<tr>
<td>Magnesium oxide</td>
<td>0.869%</td>
</tr>
<tr>
<td>Potassium oxide</td>
<td>5.665%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.086%</td>
</tr>
</tbody>
</table>

Recently, some soil studies have been carried out under the sugar-cane Research scheme of Uttar Pradesh in adjoining tracts such as Seohara sugar mill area (Bijnor Distt.) and Kosi Khao (Rampur Distt.). Since the physical as well as cultural conditions in these tracts are similar to those found in most parts of the Moradabad Distt., these soil studies give an idea of the soils in this area as well. A summary of them is, therefore, given in Appendix II for reference.
Land Revenue Classification of Soils

DUHAT I or SUPERIOR LOAM is the best among these soils. It is the standard soil of the Katehr in Bilari and Sambhal, of north-western part of Amroha and of the better parts of the trans-Ranganga tract.

DUHAT II or LIGHT LOAM is lighter in character than Dumat I or it suffers from some other defect. It is normally given to barley or bajra cultivation if irrigation is not available.

DUHAT III is the poorest of the upland loams. It is an extremely light soil and is almost exclusively given over to small grains. It compares with the bhur I, and irrigated bhur I is, usually, demarcated as wet Dumat III.

The loams are easily the most valuable of all the soils, provided they are not water-logged. But, defective drainage has caused water-logging in a large tract of gritty loam in the Udla tract of Sambhal and Amroha tahsils.

Near the homesteads or close to the settlements, receiving special attention owing to their greater accessibility and getting the advantage of extra-manuring from the dung of stall fed animals,
human excreta, house-hold refuse, etc., the dumats often grow two crops a year. Generally they are irrigated from wells or tanks. They are termed as Gauhan soils. Gauhan I is a better situated and better irrigated soil. Gauhan II is of an inferior type, suffering from shortage of water or some other defect. Their extent is, however, small. They are found close to the villages and towns having a permanent population of about 500 persons or more. The especially valuable soil near the larger towns and given to market-gardening is known as KACHHYAWA. It is, mostly a well-dressed soil and is, generally, cultivated by the Baghbans or Muraos, who are experienced and traditional market-gardeners. The soil is a fertile loam, rich in humus, which has been keenly introduced into it by the use of manures. Two or three crops a year is the general practice on this soil. It is, mostly, found near Moradabad, Chandausi, Sambhal and Amroha towns.

Clays or Matiyar Soils

Clay or Matiyar is a fine-grained soil found generally in the depressions. It is not easily worked owing to its excessive heaviness and for that reason it ranks below Dumat I. In tahsil Bilari matiyar is known as dhankar. Matiyar I is a good clay. In it rice can be grown in the kharif to be
followed by gram or some other crop in the rabi or, alternatively, it can be sown with one of the superior crops. Matiyar II is the deeper clay lying in depressions and often in wide lowlying areas locally known as the Jhadas in the Moradabad and Thakurdwara tahsils. It is essentially a single crop rice-growing soil. Matiyar III is a clay suffering from some more defects, e.g., by red.

These clayey soils bake into hard clods when dry but they are often sticky when wet. They are impervious and highly retentive of moisture. They are more common in Thakurdwara, eastern part of Moradabad, northern part of Bilari and southern part of Amroha tahsils.

SILTS OR KHADAR SOILS.

New silts are found in the khadar areas or the river valleys liable to flooding. They are usually very fertile as they contain the grains of mineral matter newly brought down by the streams. They are rich in organic matter. They are also easily worked and are retentive of moisture. Khadar I is a silt found at a higher level and, therefore, is less liable to flooding. Khadar II is the silt of an area more liable to flooding than Khadar I and it is of medium quality. Khadar III is a precarious soil, more sand than silt. Such a soil
may be one year silt, the other year sand owing to annual flooding. Because of its uncertain nature it has the least attraction for cultivators, though it is quite fertile and, therefore, sometimes, we may see a fine rabi crop coming up through a covering of pure sand. In some localities the silt is used for growing melons and early summer vegetables. There it is known as the Fales Khadar.

Sands or Bhur soils.

The bhur is a wind-borne soil, very porous and easily tilled. It is not rich in humus for it has accumulated against the stumps of former trees. The free passage of water through it, however, washes out both the existing plant food and any manures which may be fed to it, so that it is constantly hungry. It suffers most in a wet cycle it gets water-logged. Bhur I is a light sandy soil on a level surface. It is cultivated regularly, rabi in one year and kharif in the next. The percentage of wheat, sugar-cane and double cropping has, however, gone up as a result of tube-well irrigation. Bhur II is an inferior sandy soil on an uneven surface. Bhur III is a still worse soil. It may be badly eroded so that the bare khapar has been exposed. It is the poorest of all the soils and is on the margin of cultivation. The bhur soils are very extensive in the bhuralands of Basampur, Sambhal, Amroha and Bilari tahsils.
Cultural Influence on soils.

Since this soil classification takes into account many relatively quickly variable factors such as proximity to settlements leading to the development of the ganhan and kachhiana, the progress of irrigation causing a difference between the dry and wet soils, etc., the distribution of soils changes in the course of time. Thus the ganhan area in Moradabad tahsil alone increased from 688 acres in 1905 A.D. to 2920 acres in 1939 A.D. As more and more neighbouring land comes in the sphere of influence of a growing town, its soil gradually improves from the ordinary dhamat, matiyar or bhur into the ganhan or kachhiana as shown by Fig. 13. But when the town further encroaches upon the nearby kachhiana, the soil would become agriculturally unproductive, since roads, railways, factories, residential quarters and other such things would replace the fields. This urban erosion of soil is actually occurring in the suburbs of Moradabad, Sambhal and other towns.

Thus the soils are passing through a cultural evolution. In the initial stage a virgin waste-land is brought under cultivation. The original forest or grass cover is cut down or grazed and the soil is ploughed. It may, at that time, be quite distant from permanent settlement of the cultivators, who make long

EVOLUTION OF SOILS

HAUZ BHADESRA

DAULAT BAGH MUSTEHKAM

INDEX

1940-41

1873-74

1940-41

1871-72

(SOURCE: SETTLEMENT VOLUMES)

FIG.43
journeys to grow a casual crop there. As cultivation on it gradually progresses, the original soil profiles are disturbed many times. Later on, it becomes necessary for its cultivators to settle on it in small hamlets. Some of the villages grow into the size of towns and begin to encroach upon the neighbouring land. The town's influence the nature of crops grown in their neighbourhood and promote the intensity of tillage, which is the main character of the senhan and kachhiana soils. But, when roads and buildings are extended there the process of evolution becomes complete: the initial wasteland again becomes unproductive, agriculturally.

**PHYSIOGRAPHIC UNITS**

The district may be divided into four main physiographic units as under:

A. The Trans-Ramganga Tract,
B. The Ramganga Valley,
C. The Central E-angar and Bhur Uplands and
D. The Ganga Valley Tract.

Fig. 14 shows these units and their subdivisions.

A. The Trans-Ramganga Tract.

It is sub-divisible into two parts:

1. the Upland Tract of Northern Thakurdwara and
2. the Trans-Ramganga Lowlands.
The Upland Tract of Northern Thakurdwar

extends southward upto the Kurka nadi, while the lower reaches of the Jabdi nadi mark its western limit. It lies adjacent to the terai-bhabhar region of Nainital and is, generally, more than 700 feet above the mean sea level. Its central and eastern sections consist of an undulating country (cf. Ramnawala). But, the north-western section is rather more level.

All the streams of the tract, viz., the two Jabdis, the Ispkana, the Kurka and the Dhendi flow in deep and narrow channels which get dried up in winter.

The Trans-Ramganga Lowlands are more level than the upland described above. The Dhela nadi divides them into two parts: a crescent-shaped tract to its north-west and a triangular tract to its south-east. The latter is bound by the Ramganga on the west and by the Bahalla-Kosi streams on the east and south. These tracts lie at 600 to 700 feet above mean sea level. They have, in general, a stiff loamy and clayey soil wherein wells can be easily dug, the water-table varying from 5 to 10 feet. Here and there some clayey depressions, known as 'jhaddas', are also found. A block of jhadda villages lies between the Kashipur Road and the Rajhers nadi and another similar block lies along the eastern bank of that stream. A ridge of light sandy soil runs betwixt
these blocks rising into the sand dunes of Bhaipur. Various streams such as the Repi, the Kurka, the Damdama, the Dhela, the Rajhera and the affluents of the Bahalla nadi drain these lowlands and there is ample surface water.

B. - *The Ramganga Valley.*

It also includes the Kosi Khadar, the Dhela khadar and the Ganga khadar all of which combine with it in the lower reaches of these streams. All these khadars are generally below 650 feet above the mean sea level.

Most of the valley falls in the Thakurdwara and Moradabad tahsils. Its width varies from 3 miles in the north to 12 miles in the south, where it combines with the Kosi khadar.

As far as the town of Moradabad, the right bank of the Ramganga is well-defined by a high ridge of light and sandy soil scoured into by innumerable ravines. But, to the east of the town the ridge disappears altogether and the change from the khadar to the upland is gradual. Here, during high water periods, the Ramganga overflows its bank into the Gangan valley. The whole of the Ramganga valley is subdivisible into two levels as under:

(a) Ahtmali or frequently flooded lower level

(b) Mustehkam or less frequently flooded upper level.
C. The Central Bangar and Baur Uplands.

This region comprises the major part of the district. Its individuality arises from the fact that it serves as the main water-divide between the Ramganga valley on the east and the Ganga valley on the west. Its eastern boundary is marked by the ridges running along the right banks of the Ramganga and the Gangan. Its western boundary is marked by the broken scarps overlooking the Ganga khadar. On the north and south, it extends into the districts of Bijnor and Budaun, respectively. It is a diversified area and may be subdivided into the following tracts:

1. The Ramganga-Karula-Gangan Doab,
2. The Upper Gangan Valley,
3. The Gangan-Ban Doab,
4. The Ban-Gangan and Central Aroha Baur,
5. The North-Western Bangar of Aroha and Hasampur,
6. The Katehr Bangar of Bilari and Eastern Sambhal,
7. The Ari Jhil Area and the Ari Valley,
8. The Sot Valley,
9. The Udha and Farmer Tracts, and
10. The Bhurlands of Hasampur and Sambhal.

The Ramganga-Karula-Gangan Doab lies between the Karula-Gangan and the Ramganga streams.
The Upper Gangan Valley is a denuded tract, where considerable soil erosion has occurred.

The Gangan-Ban Doab possesses a light and porous soil of a reddish hue, varied in places by sandy patches owing to the extensions of a small bhur ridge from the Bijnor District. In the south, the villages become sloping and the soil deteriorates.

The Ban-Gangan and Central Amroha Bhur runs parallel to the Ban nadi and merges with a broad upland of light soil in the north of the Bilari tahsil. It has also some off-shoots into the central parts of Amroha tahsil, where it is known as the Central Amroha Bhur. The bhur ridges rise, sometimes, over 720 feet high, and make some prominent features in local topography.

The North-Western Bangar lies to the north of the Udla and west of the Central Amroha bhur. The villages on its northern border have a loam and clay soil. There, a small and rather irregular line of bhur, extends southwards from Bijnor as far as the sand dunes of Gajasthal. To the west and south, the soil becomes lighter and the surface is gently undulating. At places ridges containing inferior loams and depressions of stiff loam and clay are also found. All these tracts may be grouped together as
Inferior uplands owing to their uneven topography and light soils. In their northern parts they are over 700 feet in height which decreases southwards. The water-table, in the higher and northern parts is 20 to 24 feet deep, but elsewhere it is 8 to 10 feet deep (cf. Latifpur and Khidmatpur).

The Katehr Bangar is mostly a level upland with an elevation of 600 to 650 feet. Within it, the Sot and the Ari nadis have formed narrow and sinuous valleys. A broken ridge of sandy soil runs between the Ari and the Sot and a smaller one runs between Sahaspur and Seondara. But, mostly this tract has superior loamy soils. The water-table varies between 10 to 12 feet in depth (cf. Naglia Kathair, Tah. Sambhal and Bahadurpur, Tah. Bilari).

The Ari Jhil Area or the upper part of the Ari valley abounds in depressions, which contain clayey soil, and are often liable to inundation and waterlogging. (Fig. 15) An uneven surface and a considerable amount of keller infection in the soil are its chief characteristics. The Ari river has a very narrow valley, broadening gradually towards the south-east (cf. Khabri Gandu).

The Sot Valley has a gradual slope in its upper part. Lower down in its course the valley slopes become more pronounced and there are deep ravines in
then. (See Fig. 8). Its khadar is a narrow belt seldom more than a quarter of a mile in width and in many places high spurs of bhur run down to the river bank. This khadar, though apt to become water-logged after a series of wet years, is usually fertile. The valley slopes are characterised by belts of sandy loam. Upward they merge into the Katehr upland. Thus, along the Sot, every village is characterised by three distinct 'hara' - the level upland, the 'kharar' slope and the khadar below (cf. Pahladpur, Tah. Sambhal Fig. 4).

The Udla And Panmar Tracts consist of a compact block in the north of Sambhal and south and South west of Amroha. The Udla tract has a gritty loam as its soil. It is almost flat with a very gentle slope to the south-east. It has a defective drainage, which is blocked by the criss-cross ridges of bhur, and is liable to serious water-logging during a wet cycle. The water-table is seldom more than 8 feet below the surface; but the water actually oozes out on the surface in wet years. The only outlets are the few chhoyias, which are shallow and narrow seasonal streams which lead into the Sot, (cf. Nizam Nagla and Khaliqpur Kalan, Tah. Amroha). In the Panmar tract, the slow passage of water coming from the south and centre of the Central Amroha Bhur
causes serious damage to the soil and eventually reaches the Sot nadi or the Ari Jhil area. The prevailing soil is good stiff loam and clay, though the frequent patches of sterile keller testify to the seasonal flooding.

The Bhur lands of Basantpur and Sambhal extend along the whole length of the district from north to south. This area consists of a succession of rolling sand-dunes running generally parallel to one another with somewhat firmer soil in the intervening Chholys beds (cf. Bagharpur Chholys, Fig.4). The crest of each successive ridge is slightly lower than the preceding one, till the final ridge overlooking the Ganges khadar is reached.

While the Chholys of the east flow through the uplands, those of the west flow due south till they approach the Ganges khadar. Then they force a passage through the high ridge and join the Jhils or the Bagad nadi. In the Chholys the wells can be sunk easily and the water table varies from 5 to 10 ft.

Villages along the western margin of the Bhur have a part of their area in the Bhur upland and a part in the Jhils or khadar below (cf. Chaki Kheda). The portion of the khadar and Bhur area varies from village to village, but, generally the Bhur area predominates as shown by Fig.4.
The Ganea Valley Tract

The width of the Ganga Valley Tract varies from two miles in the north to eight miles in the south. Its area in the district is about 269 square miles but it is liable to vary with the shifting of the channel of the river. Every year it is the scene of devastating floods, which have caused a great havoc to the soil of this tract. In the west there is a wide khadar, but eastwards, there is a belt of higher ground, and a chain of swamps and jhils lying at the foot of the Bhor escarpment. It may be subdivided into the following four parts:-

1. The Jhil Belt,
2. The Bagad Upland,
3. The Open Khadar and
4. The Diluvial Tract.

The Jhil Belt is a swampy area. Sometimes, the swamps connect and form streams, but otherwise they are merely detached pools of water, occasionally widening out into large jhils, e.g., the Bagad Jhil, Jabda Jhil, Sam다 Jhil and the Bhorar Jhil. The Jabda Jhil is the largest, having an area of three square miles. A large swamp known as the Krishmi Jhil is situated in the extreme north of the khadar. Into it flows the Krishmi Nadi and from it flows out the Bala Nadi.

The Bagad Upland extends from near Sujmana village in the north to Budaun border in the south, save for a short distance opposite Hasanpur, where the Jhil
tract merges into the Khadar without any interruption. The rise in the level from the Jhil belt to the upland is gradual but it is still marked. The distinguishing features of the upland are a thirsty and stiff soil, either loam or clay. A fair proportion of the reh-infection is also present especially in the south, where it is leased for the manufacture of crude glass. Here and there, long and narrow Jhils are found. A group of twelve villages between Aaserwa and Shahbazpur Daur has sand dunes. The water table in this tract varies from 8 to 12 feet in depth.

The Open Khadar lies next to the Bagad upland. There are many semi-perennial streams such as

1. The Baia, which continues southwards from the Krishni Jhil and joins the Ganga near Kankather,

2. The Matwali, which flows east of Kankather,

3. The western Bagad which emerges from the swamp near Deothi and ultimately becomes Mahawa and flows into Budaun, and

4. The Eastern Bagad, also known as the Tikta, which takes its rise from the Samda Jhil and flows into Budaun.

There are many smaller streams also which dry up in winter. In addition, many wide and shallow depressions carry flood water during the rains, when the Ganga river discharges into the Mahawa and the latter fills the Tikta and the swamps at the foot of the Lhur cliffs. Then, the
whole khadar is an unbroken sheet of water, save for the higher portions of the Bagad upland. There are few years in which the wheat crop is not seriously injured by these floods (cf. Katena old, Katena New and Bhagwanpur Khadar).

The Diluvial Tract adjoins the channel of the Ganga river. It is cut up in all directions by the old channels of the river. Its northern portion, from the Bijnor border to Dalinda is a waste land containing tamarisk and fetching grass. The central part of the tract varies from barren sand to a fine silt. From Jallupur to Sirsa again there is a stretch of waste. But, to the south of Sirsa, there is a fine and highly tilled area, where, the construction of a dam by the canal department and its extensions by private philanthropy have saved the villages from the ravages of the floods.
Section B: Climate and Natural Vegetation.

Situated in the upper Ganga Plain and in proximity to the Himalayan mountains, the Moradabad district enjoys a subtropical continental climate of the general monsoonal type. All the elements of weather and climate are influenced by the seasonal rhythm.

Temperature fluctuations are seldom adverse to the cultivation of crops here. The mean temperature for the year is about 75°F. The maximum temperature rises to about 103°F in May or early June. The minimum temperature falls to about 46°F in January. Light frosts occur in January and February.

Rainfall has a greater influence on the plant growth and on the agricultural activities of the people in this area. The rainy season starts, normally, by the end of June. The monsoon blows from a south easterly direction. It is mainly the Bay of Bengal current. The rainfall varies considerably in time and place according to the track of the monsoonal depressions.

Fig. 16A shows the situation of the district in Northwest Uttar Pradesh. Fig. 16C shows the weather conditions on a day in July. Fig. 16D shows these conditions on a day in January. There is no meteorological observatory in this district. Only rainfall is recorded at the six tahsil headquarters. Bareilly has the nearest observatory and its temperature and humidity data is taken to represent for Moradabad also. It is given in Appendix table 1 for reference and Fig. 17A shows it graphically. Bareilly does not record evaporation data for which has been utilised from Bahraich which lies in similar climatic conditions and has been shown graphically in Fig.16E. A statement of evaporation at Bahraich is given in the Appendix table XI for reference.
Vagaries of Rainfall

On an average, the district annually receives about 39 inches of rain in 50 days. Out of that about 80 percent is received during the summer monsoon period. At Thakurwara it amounts to about 44 inches (in 58 days), out of which more than 84% comes in June - September period. At Moradabad it is about 42 inches (in 51 days), out of which nearly 85% falls in the rainy season. But at Hasanpur it is less than 34 inches (received in 43 days). Fig. 16b (and Appendix table 11) shows the normal rainfall at the six rain recording stations of the district*. **

Much fluctuation occurs, everywhere, in the yearly rainfall as is clear from Fig. 17b. To take a few examples Moradabad received only 21.46 inches of rain in 1915, while it amounted to 70.36 inches in 1924 (Fig. 17f). Thakurwara got only 17.71 inches in 1913 and 72.21 inches in 1924. For the district as a whole, the driest year on record is 1905 when it rained 21.1 inches only, while the wettest year on record 1879 received 65.25 inches. Then, Moradabad received as much as 78.8 inches and Hambhal 78.7 inches. *

* isohyets have been interpolated.
** The rainfall data for making the graphs in Figs. 17b and 17c has been utilised from the District Census Hand Book (Census 1951), Moradabad District, Pub. Allahabad, 1954, p. 206-227.

Figures based on Singh, J.K., Assessment reports of Moradabad and Thakurwara tahsils (1942)

Figures based on Dingh, Assessment Reports of Moradabad and Thakurwara tahsils (1942)

Figures based on Dingh, Assessment Reports of Moradabad and Thakurwara tahsils (1942)
Not only that the totals of annual rainfall show wide fluctuations, but the seasonal rainfalls also vary considerably in different years as shown by Fig. 17C. Appendix table X shows the vagaries of summer monsoon rainfall at Thakurdwara. As noted above, most of the rainfall is concentrated in the summer monsoon period extending from June to September. It is also clear from Fig. 17B. It is a very critical period; the kharif crops are standing under the scorching summer sun and needing a regular supply of water at proper intervals and in proper quantities. But, the rainfall is very undependable and uncertain. The wet years have devastating floods in this season, while the drought years have scarcity in areas unprotected by irrigation, so that in both cases there is a danger to the growing crops and the balance of land use is upset.

In September and October the fluctuations of rainfall are very great. Sometimes, there is an abrupt cessation of rain; sometimes, the rains continue too long and heavily, too. In both cases the standing kharif crops are damaged and the sowing of rabi is hampered.

The totals of rainfall, annual or seasonal, can give little indication as to the suitability of climate for the agricultural activities in detail. The totals may be obtained by adding together rainfalls coming at odd times. The rain may be too early or too late for the sowing of
crops or it may be interrupted by long breaks causing immense damage to the growing crops, or it may continue too long delaying the harvesting operations. But nobody can be certain of what amount of rain will fall when and it is under this variability of rainfall that the farmer has to work in this area so that he is naturally a fatalist in his outlook upon life.

**Monthly rainfall**

Fig. 17 shows graphically the maximum, minimum and mean monthly rainfall. The table below gives the relevant data:

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Monthly Rainfall at Koradabad (Inches)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Maximum</td>
</tr>
<tr>
<td>Jan.</td>
<td>5.3</td>
</tr>
<tr>
<td>Feb.</td>
<td>5.2</td>
</tr>
<tr>
<td>March</td>
<td>3.5</td>
</tr>
<tr>
<td>April</td>
<td>2.1</td>
</tr>
<tr>
<td>May</td>
<td>4.5</td>
</tr>
<tr>
<td>June</td>
<td>17.1</td>
</tr>
<tr>
<td>July</td>
<td>35.3</td>
</tr>
<tr>
<td>Aug.</td>
<td>21.0</td>
</tr>
<tr>
<td>Sept.</td>
<td>16.9</td>
</tr>
<tr>
<td>Oct.</td>
<td>7.7</td>
</tr>
<tr>
<td>Nov.</td>
<td>2.2</td>
</tr>
<tr>
<td>Dec.</td>
<td>5.2</td>
</tr>
</tbody>
</table>

It is clear from these figures that all months show a great range of rainfall. But, in June, rain varies from 0.2 to 17.1 inches, in July from 35.3 to 3.0 inches, in August from 21.0 to 0.6 inches and in September from 16.9

*Planford H.E., Climates and weather of India, Ceylon & Burma p.345. Figures for 37 to 39 years.
to nil inches. While the vagaries of rain in June affect the sowing of kharif crops, those in July and August affect the growth of these crops. But September's vagaries in rainfall are back-breaking, since they not only adversely affect the standing kharif crops but also do considerable damage to the sowing of rabi by causing water-logging when too much.

The figures in the table below show still greater range of rainfall in these months:

Table 2

<table>
<thead>
<tr>
<th>Month</th>
<th>Rain at Amroha</th>
<th>Rain at Koradabad</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>June</td>
<td>14.45</td>
<td>0.75</td>
</tr>
<tr>
<td>July</td>
<td>22.70</td>
<td>5.77</td>
</tr>
<tr>
<td>Aug.</td>
<td>29.34</td>
<td>0.08</td>
</tr>
<tr>
<td>Sept.</td>
<td>20.98</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Herein, the range in the rainfall of June at Koradabad, of August at Amroha and of September at both Amroha and Koradabad is considerably greater than that shown in table 1 above.

Appendix table III shows the monthly rainfall in the district in recent years 1953-1958. A reference to it will show that the rainfall has been medium in these years and the range of total yearly rainfall has amounted to

16.32 inches only. The rainfall in June has always been low varying from 1.62 to 3.92 inches. That in July has varied from 6.82 to 18.96 inches, in August from 6.05 to 13.75 inches, in September from 2.59 to 17.62 inches and in October from nil to 12.82 inches. Appendix table IV shows the actual monthly rainfall at Anrora in these years (1954-58). It shows that the fluctuation of rain in all these months has been higher at this station than the average for the district shown in table III. But, it has been still higher in the case of September (5.96 to 27.17 inches) and October (nil to 16.73 inches). Thus the fluctuation in the late monsoon rainfall has been considerably higher in recent years than that shown in table I above.

Season of Retreating Monsoons

By October the trough of low pressure over northern India is broken up. The sun has moved to the south of the Equator. The summer monsoon retreats. It is marked by longer and longer breaks in the rains. The occasional heavy rains of the month of October are due to a rare persistence of the monsoon or of the transitional depressions. In November, light, dry and cool winds blow owing to the anticyclonic distribution of atmospheric pressure prevailing in the north-west of the country.
From December to March, the district has lower temperatures, but, owing to the protection afforded by the Himalayas, the bitter cold prevailing in Central Asia, at this time, has little effect, here. The total precipitation in the winter season is 3 to 5 inches. This is received from a number of westerly depressions which have traversed long distances. In contrast to the heavy showers of the rainy season, the winter rainfall is generally steady and gentle. The sky gets overcast, gradually, with a stratus or nimbo-stratus cloud and, after a little turbulence, it starts raining or drizzling which may, sometimes, continue for more than 24 hours at a stretch. But, more often, only passing showers are received. December, generally, remains clear. January and February get six or seven falls of rain, which are generally enough for the cultivation of unirrigated wheat. But when they fail, in time or amount, the cultivator in the unirrigated areas is put to great trouble. The occasional hail and thunderstorms of this season are also harmful for the rabi crops. Their occurrence in February damages seriously the flowering gram and oilseeds.

**Dry Hot Season**

From early in March the temperatures begin to rise rapidly and, due to local differences of temperature,
variable winds blow. These winds pick up dust and sand particles and blow them over considerable distances, taking an appearance of little duststorms. Whirlwinds are a common feature of this season. The dry heat of March helps in the maturing of rabi crops, but sometimes, owing to its great aridity, the grain shrivels and the yield remains low. The light winds of March and early April are very helpful in the winnowing of rabi harvest. This work is still being done in the crude old way by throwing up the threshed ears of grain into the air. In April and May, the midday wind takes a burning touch. It is then known as loo. The early part of June is, usually, the hottest and driest period of the year. Then the maximum temperatures may reach 103°F.

April to June is a dry season under a scorching sun. Only casually some thunderstorms may bring some downpours of rain, which are of particular importance to the young cane crop. By the end of that month, however, humidity increases in the atmosphere and the temperatures may fall with the burst of summer monsoon.

Evaporation and Precipitation Effectiveness

When we consider the effectiveness of the precipitation in an area we must know not only the amount and nature of rainfall but also that of the evaporation. But, when we consider evaporation in relation to the plant-world we have to consider two factors, viz.,
(a) evaporation from the soil surface, and
(b) transpiration from leaves and stems.

Whereas (a) is a physical process, (b) is also partly controlled by the physiological processes of the plant.* Measurements of these factors, in this country are very scanty. The knowledge of evaporation from the soil under natural conditions is practically nil. Experiments on soil evaporation are needed before one could venture to draw any general conclusions. The water-deficiency graph (Fig. 15) shows that July, August and September have a water-surplus while all other months have a water-deficiency, March, April and May, in particular should be noted in this context. Hence the cultivator must need irrigation facilities if he has to raise crops throughout the year.

The effect of rainfall on agriculture is also accentuated by the distribution of soils and topography. Thus the light and dry soils of the bhurlands of the west present an appearance of greater aridity than total annual rainfall would warrant. Thirty-four or thirty-five inches, after all, are not a small amount of rain as compared to the normal in most parts of north-western India.

As a result of the combined effects of the differences in rainfall evaporation, soils and topography we find

considerable differences in the vegetation and crops found in various parts of the district as will be seen in the sequel.

**Tracts of Climate**

Locally, the climate differs considerably in the north-eastern and the western parts of the district. To the east of the 40-inch isohyet (Fig.16b), a higher precipitation and proximity of mountains give a sub-montane character to the climate. To the west of this line the rainfall sinks comparatively rapidly to less than 34 inches in the Ganga khadar. In a way the isohyet of 40 inches divides the district into two climatic divisions, namely,

1. The North-Eastern Tract, comprising the tahsils of Thakurdwara and Moradabad.
2. The Western Tract, comprising the rest of the district.

The North-eastern tract is not only characterised by a higher amount of rainfall but also by a better distribution of precipitation through various years. Appendix table VII gives the actual rainfall at Moradabad in the years 1954-55. It shows that never in these years the amount of precipitation was less than 40 inches while the range amounted to only 11.50 inches or 28.5 percent above the minimum rainfall in the period. Even the rainfalls of various months did not show
the wide differences in different years as have been noticed at Amroha. Similar evidence is provided by appendix table IA, which gives the actual rainfall at Thakurdwara in these years.

In the western Tract where the precipitation is normally less than 40 inches its vagaries are also more marked and they increase towards the south-west (cf. Appendix tables IV, V, VI and VII). Thus at Silar the range of annual rainfall in the years 1954-58 has been 36.6 percent above the minimum. That at Amroha has been 53.9 percent. At Hasapur it has amounted to 56.7 percent. At Sambhal it was 90.5 percent.

In the north-eastern tract a higher and better distribution of rain, a larger number of streams, the predominant heavier soils and a more even topography have combined to make it quite a damp tract. Moist deciduous woods are the natural vegetation, while irrigation of crops seems to be unessential.

In the western tract a lesser and fluctuating precipitation, fewer streams, lighter soils and an undulating surface have made it relatively more dry. Drought resisting woods and coarse grass comprise its natural vegetation, while irrigation seems to be quite essential for the cultivation of better crops. However, a distinction must be made, here, between the khadar areas such as those of the Ganga river
and the sot nadi and the bhur and bangarupland. The khadar lowlands are damper owing to their inundation by the streams as well as due to their higher water tables. But, the bangar and bhurlands are much more dry than their rainfall would indicate. The bhurlands, owing to their sandy soils, are the worst in this respect.

On the whole, the climate is quite suitable for the agricultural use of land throughout the district. But, the micro-regional differences of climate as also those of the soils and topography determine much of the agricultural capabilities of the respective areas.

**Natural Vegetation**

Deciduous forest is, essentially, the natural vegetation of this monsoonal district. There is historical evidence* for the existence of large and dense forest here, a thousand years ago. It was cleared or devastated when the Sultans and the Moghul Emperors of Delhi tried to establish their sway over here. Many times their armies overran the area with a view to suppressing the turbulent seethers, Pathans and Rohillas and in doing so the forests were greatly damaged. Now the woodland is confined to the riverain strips and village groves only. Climate, particularly rainfall, is the major determinant of the type of vegetation. Soil and physiographical factors control the distribution of species, and associations.

Thus, thorny bushes like berry-jhbari, kakraunda and jheend are a feature of the bhurlands. Shisham and neem (Meliaceae Indica) are common along the jhils. Babul (Acacie Aralica), wild palm and dhak (Butea frondosa) are found in the Ganga khadar and in the south of the district. In the wetter north-east and in the valley of the Ramganga dhak and khair are more common. The upland of Thakurdwara has some moist deciduous trees here and there. The leaf-fall period varies from species to species and one can see trees felling their leaves from November up to April.

Some grasslands are found in the extreme north of the Ganga khadar from Dalinda to the Bijnor border, where large herds of cattle are maintained throughout the year, while many more are sent there from the uplands during the hot weather. Elsewhere in the flood plains of the Ganga and the Ramganga rivers jhau or tamarisk grows after the annual floods. It is used for fuel and for the manufacture of baskets. The roots of the gander grass are used for preparing 'khas-khas' tatties. In the wetter north-east, patches of green but short grass are to be seen long after the rains. The north-eastern fringe has some long grasses as well. The uplands of Thakurdwara have some bamboos. The bamboos sometimes grow up to 30 to 50 feet and provide material for huts, scaffolding, basketry, mats, sticks, rafting, furniture, household and agricultural implements, etc.

*Plate IX shows the natural vegetation in the Ramganga valley.*
IX. Natural vegetation on the Ramganga Valley Slopes

X. Thatching grass near Kasanpur

XI. Screen making from thatching grass
The drier bhurlands of the west are covered with coarse grass and sita-bani weed. In places, valuable thatching grass is also found. In the adhek villages of Hasanpur tahsil, it affords a source of income to many persons. In addition to being used for thatching purposes, it is used for making a rough twine, ropes and mats. From the stalks of this grass are made sieves, winnowing baskets and the screens known as 'sirkis'.

On the central bangar, some short grass is found only along the field 'manda' or, sometimes, in the 'banjar' or wastelands where the livestock are left to roam about and graze when idle.

* Plate X shows the thatching grass. Plate XI shows sirki making.*