CHAPTER XII

IRRIGATION AND AGRICULTURAL IMPROVEMENT IN BUNDELKHAND.

As Bundelkhand suffers from scarcities, droughts and famines, the main problem of farmers has always been to procure enough water for protecting their crops from failures. The rulers of this area since very early times had also tried to stabilize agriculture by introducing irrigation.

Brief History of Irrigation in Bundelkhand

The history of irrigation in and around Bundelkhand starts from about 11th century A.D. The Bhojpur lake (11th century A.D.) near Bhopal, the largest and the most beautiful sheet of fresh water covering an area of 250 sq. miles constructed across the Betwa valley is an excellent example of the interest taken and ability shown by the old Hindu kings. (1)

Great interest was taken in Bundelkhand for the development of irrigation by many Chandel and later Bundela kings. They had done great humanitarian job by constructing large number of tanks. At Haibatpura a rock inscription gives the

(1) Manual for Minor Irrigation Works, (C.P.A. Series of 23) Planning Commission, Govt. of India, p. 9
date of one of the small groups of lakelets as Samvat 1604
(or 1548 A.D.), but most of them are undoubtedly much older.

Barwa sagar, Pachwara, Nagarwara, Kirat sagar and a host
of other tanks and lakelets were constructed later on. Late
maharaja Pratap Singh ju Deo of Orchha got constructed and
repaired about 75 tanks in Tikamgarh, Baldeogarh, Jatara and
Thrauli areas in order to mitigate the effects of famines of
1896-97 and 1901. These were, however, small and commanded
small area around them.

During the later part of the 19th century (1873) when
the British annexed Jalaun, Jhansi, Hamirpur and Banda
districts, they did not show much interest in the development
of irrigation works in Bundelkhand. Nevertheless, they
undertook the responsibility of repairing the old works which
fell out of use. Mr. Jenkinson (1866) Deputy Commissioner of
Jhansi prepared a list of 142 existing tanks capable of
repairs and 39 new projects in that district alone. Other
British officers followed his example in Hamirpur and Banda.

British government did not undertake the construction
of larger irrigation works owing to the nature of topography
of the region and the bleak prospects of returns from them.

(1) Brockman, D.L. : 'District Gazetteer of Jhansi, Vol. XXIV,
1909, p. 14

(2) District Gazetteer of Jhansi, p. 16
The economic aspect of the question dominated the early Britishers so much that even the management of the then existing tanks became problematic because these did not pay much to the government. The Special Bundelkhand Irrigation Division, constituted by them earlier, was abolished in 1877. The lakes were placed sometimes under the control of regional commissioner and sometimes under the district authorities. In Jhansi district four larger lakes, namely Pachwara, Magarwara, Arjar and Barwa Sagar were put under the control of the Irrigation Department and other twenty-five lakelets under the commissioner. Four others were placed under the direct control of district board and one i.e. Bakshi Tal under the Forest Department. Commissioner exercised some sort of over-all control on them.

In 1893 the big lakes were placed under the control of District Collector who managed them through the district Executive Engineer. This arrangement was finally transferred to the officer-in-charge of Special Tank Division of Irrigation Department. Similar is the history of other Bundelkhand districts under the British control.

**Early Protective Works and Financial Policy of British Government**

Because the tank irrigation was not remunerative at all, the British government was obliged to look at the whole
problem from the point of view of finance. But repeated threats of famines and droughts, in which government had to spend a substantial amount on relief and had to grant huge remissions in revenue, compelled the British government to change this attitude. It was this consideration that justified the construction of Betwa canal the first 'protective Irrigation work' in India. In undertaking this project, the government had set aside the question of making returns from it. It was primarily designed to protect a section of Bundelkhand from the vicissitude and scourge of famines. Encouraged by the results of this policy, other projects, such as Ken, Dasan, Pahuj and Paisuni canals were also taken up soon after the Betwa canal project was completed. There must, however, be a limit to the expenditure which the government could have incurred on a particular project. The Irrigation Commission in 1905-06 considered that 'in general it would be permissible to spend up to a maximum of three times its 'direct protective value,' (1) for each acre irrigated 'to which may be added the capitalised value of the net revenue anticipated from each such acre in payment for

(1) Direct Protective value of an acre had been defined as the 'capitalised value' of the average annual expenditure on famine relief divided by the area brought under additional irrigation - Report of I.I.C. 1901-03, Part I (General) by Sir, Colin C. Scott, Moncrieff, p. 31
water provided. (1) The sum of these items was termed as 'permissible capital out-lay per acre' and in case of every protective work submitted for sanction, 'it had to be shown that its permissible out-lay would not be exceeded.'

Independence and After

Soon after the achievement of Independence in 1947, the provincial governments were set at improving the agricultural conditions throughout the country. Pant ministry in Uttar Pradesh gave top priority to irrigation projects in Bundelkhand districts of Jalaun, Jhansi, Hamirpur and Banda. The commercial attitude of the British government was substituted by welfare policy. The classification of canals into 'productive' and 'protective' was given up in accordance with the recommendations of the Irrigation Commission (1901-03) and a simple classification i.e. 'Major' and 'Minor' works was adopted. This revision of classification was instrumental in removing financial rules regulating the construction of protective works.

U.P. Government launched out a Rs. 7.5 crore irrigation programme for the proposed seven projects in Bundelkhand districts. These were Matatila, Lalitpur dam, Saprar dam

(all in Jhansi), Kabrai dam (Hamirpur), Ragwan dam, Arjun
dam and Arjar dam. By their construction, it was estimated
to benefit five lakh acres of land by irrigational facilities.

In M.P. Bundelkhand, little progress could be made as
this area became a part of a small Vindhya Pradesh state.
By the time second five year plan came to be launched, Datia,
Tikamgarh, Chhatarpur and Panna became part of the big Madhya
Pradesh state which has greater resources. Soon after the
reorganisation of states twelve new irrigational projects
were mooted out for the M.P. Bundelkhand districts at an esti-
mated cost of 4.26 crore rupees to irrigate about 1.41 lakh
acres of arable land. (1)

Out of these twelve projects, six were in Bundelkhand
and six Baghelkhand. In Bundelkhand districts the projects
were Nagda nala and Nandan-wara in Tikamgarh, Pahari,
Devendra Nagar and Upper Ken in Panna and Beniganj in Chhatar
pur. Out of these only two i.e. Nandanwara and Beniganj were
approved by Planning Commission and completed.

Most of these works are small and medium irrigation
projects. Financial assistance for such works now comes
from Central Government from 'Miscellaneous Development Fund'

(1) Report of M.P. Water Rates Committee, 1959-61, Govt. of
M.P., 1962 pp. 32-33
under special programme for improving conditions in scarcity areas. This assistance is given in the form of loan which is interest free for the first five years and is repayable by the State in twenty equal instalments commencing from the sixth year.

Sources of Irrigation in Bundelkhand

Wells, tanks and canals are the principal sources of irrigation in Bundelkhand. Their relative importance depends on a number of geographical factors such as topography, geological structure, types of soil, amount and distribution of rainfall and resourcefulness of the peasants.

In Plate XXX map No. A, total geographical area, net cultivated area and total irrigated area of each tahsil have been shown by proportionate squares. It may be noted from the map that in almost all the tahsils in the northern part of the region, the size of cultivated and net irrigated areas as against their total geographical area is quite conspicuous. Even slope, fertile soils and the net work of canals (also large number of wells) are responsible for this phenomenon. In southern part, specially in Panna and Pawai tahsils though the geographical area of these units is comparatively large, yet the cultivated and irrigated area is very small because not only the rainfall of this area is more (45") but also the relief is high and soils infertile i.e. stony.
### Table No. LVI

Irrigated area in acres and percentage (by different sources) (Av. of 1959-60 to 63-64)

<table>
<thead>
<tr>
<th>Districts</th>
<th>Canals</th>
<th>%age</th>
<th>Tanks</th>
<th>%age</th>
<th>Wells</th>
<th>%age</th>
<th>Other sources</th>
<th>%age</th>
<th>Total irrigated area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jhansi</td>
<td>76,898</td>
<td>49.3</td>
<td>5,405</td>
<td>3.2</td>
<td>73,917</td>
<td>47.4</td>
<td>277</td>
<td>x</td>
<td>156,497</td>
</tr>
<tr>
<td>Jalaun</td>
<td>202,050</td>
<td>99.5</td>
<td>81</td>
<td>x</td>
<td>1,021</td>
<td>x</td>
<td>202</td>
<td>x</td>
<td>203,354</td>
</tr>
<tr>
<td>Hamirpur</td>
<td>119,188</td>
<td>91.6</td>
<td>477</td>
<td>x</td>
<td>10,469</td>
<td>7.6</td>
<td>579</td>
<td>x</td>
<td>130,713</td>
</tr>
<tr>
<td>Banda</td>
<td>197,350</td>
<td>99.0</td>
<td>1,805</td>
<td>1.0</td>
<td>16,665</td>
<td>0.8</td>
<td>408</td>
<td>x</td>
<td>201,228</td>
</tr>
<tr>
<td>Datia</td>
<td>1,160</td>
<td>10.0</td>
<td>73</td>
<td>x</td>
<td>8,955</td>
<td>90.0</td>
<td>45</td>
<td>x</td>
<td>10,133</td>
</tr>
<tr>
<td>Tikamgarh</td>
<td>12,639</td>
<td>11.7</td>
<td>18,797</td>
<td>17.1</td>
<td>78,736</td>
<td>71.1</td>
<td>298</td>
<td>x</td>
<td>110,520</td>
</tr>
<tr>
<td>Chhatarpur</td>
<td>4,054</td>
<td>3.6</td>
<td>8,093</td>
<td>7.3</td>
<td>96,264</td>
<td>88.1</td>
<td>681</td>
<td>1.0</td>
<td>109,074</td>
</tr>
<tr>
<td>Panna</td>
<td>4,354</td>
<td>40.0</td>
<td>711</td>
<td>10.0</td>
<td>4,829</td>
<td>50.0</td>
<td>276</td>
<td>x</td>
<td>10,170</td>
</tr>
<tr>
<td>Total</td>
<td>617,693</td>
<td></td>
<td>35,442</td>
<td></td>
<td>275,788</td>
<td></td>
<td>2,766</td>
<td></td>
<td>931,689</td>
</tr>
</tbody>
</table>

x represents less than 0.5%
Figures noted in each Tahsil represent the percentage of irrigated area to total geographical area.

Map B shows these very aspects districtwise and map C region-wise (i.e. U.P. and M.P. Bundelkhand).

Percentage of irrigated area has also been shown on Plate XXXI map No. A (tahsil-wise) and map No. B (district-wise). An examination of map A shows that Jhansi, Nivari, Tikamgarh and Naraini have largest area under irrigation i.e. 30.0% of the total cultivated area. These are followed by Kooch, Jalaun, Rath and Chhatarpur tahsils with 25 to 30% area, Lalitpur, Jatara and Banda tahsils have 20 to 25% of cultivated area under irrigation.

The least important are the tahsils of Panna, Pawai, Ajaigarh and Bijawar for reasons already noted. In Garautha, Maudaha and Hamipur tahsils the cause of low percentage is owing to the presence of deep black soils which do not need much irrigation.

Map No. B represents these percentages district-wise.

**Progress of Irrigation in Bundelkhand**

The inset diagram in Plate XXXI shows that in M.P. Bundelkhand the progress of irrigation since 1951 has been extremely slow. It is much less in size as well as in growth.
rate, than its counter part i.e. U.P. Bundelkhand. The reason is that while some major irrigation projects were undertaken in the former after Independence, only small projects were taken up in the latter.

In the northern plain besides the factor of surface relief, resourcefulness of the peasants is also favourable for development of irrigation works. Both canals as well as wells are cheaply constructed there. Resourcefulness of peasants is reflected in largest number of private wells for irrigation in area.

Wells

In Bundelkhand wells have been the cheapest source of irrigation in all those parts where water table is high and sub-surface rocks clayey. They were chief source of irrigation during the pre-canal period. Usually in an area where permanent water table is more than 40 ft. deep, well-irrigation becomes expensive. They are also prohibitive in the areas where sub-surface rocks are hard and crystalline. The cost of digging a well is not more than 100 to 180 rupees in alluvial tracts. It is three times more in granite country, where the supply of underground water is also scanty. The main difficulty in the way of well-irrigation in the northern districts is along the courses of the streams where water-
table varies from 60 to 100 ft. or even more. In the interior parts of Jalaun, Hamirpur and Banda districts (in the inter-fluves) the depth is, however, moderate i.e. 25 ft. to 35 ft.

In Bundelkhand, soon after the introduction of canal irrigation, wells as a source of irrigation have declined in importance in the areas served by canals. Canals in turn have raised the local water-table and made well-irrigation more popular in parts where canal water does not reach but which are never very far off from the canal zones. At the same time canals at various places are responsible for changing the neutral character of water in the wells into hard water which is not suitable for irrigation as such many wells have been abandoned. It may, therefore, be noted that canals and irrigation from them have worked out different results in different parts of Bundelkhand.

In the red soil tract, south-east of Lalitpur, as also in the hilly areas of Girwan (Banda), wells are few in number. Those in existence yield scanty supply of water. In many parts of red soils the water-table is at a depth of 70 ft. or more (as in Moth tahsil). The depth increases near the high banks of Betwa and Ghasan rivers. These factors discourage the use of wells for irrigation in these areas.
There are roughly 65,000 irrigating wells in the entire region. This total is held in 50:50 ratio by U.P. and M.P. Bundelkhand. Except for Chhatarpur, where wells are numerous, they are very much less throughout Tikamgarh and Panna districts.

In Bundelkhand wells irrigate about 29% of the total annually irrigated area. They usually work well in normal years but when droughts occur for prolonged periods, they also dry up. Water, however, remains in all those wells which are found near the canals, tanks and reservoirs. These water bodies have considerably affected the local water-table as already discussed.

In Datia and Chhatarpur, well is the most important source of irrigation even now, but it has declined in importance in Jalaun, Hamirpur and Banda. In Datia 90% and in Chhatarpur 99% of the total irrigated area is under well irrigation. In Jhansi and Panna 40 to 50% of the irrigation is done by wells. The reason of their popularity as a source of irrigation in Chhatarpur tahsil may be found in the nature of surface configuration which bars the construction of canals and big tanks.

In the region as a whole, irrigating wells are mostly private and are non-masonry. The clayey sub-surface rocks in
the northern plain make it possible for their being non-masonry. Whenever sandy beds intervene, they are of course masonry. There are no tube-wells in the whole region and the efforts of U.P. Government to explore their possibility in the Trans-Yamuna region have so far failed due to the absence of saturated strata at reasonable depth.

**Tanks**

Irrigation from tanks, lakes, reservoirs and village ponds is included in this category. It is a very popular source of irrigation, specially in southern parts of Bundelkhand. Tanks were constructed since very early times in order to mitigate the effects of droughts and famines and ensure cultivation in this region.

Tank irrigation is controlled by relief of the land, the nature of the underlying rocks and the amount of rainfall. We have already remarked in the discussion on the hydrography of the region that in the country of granites and gneisses, the surface is undulating and wherever the streams have been intercepted by quartz reefs and lava dykes, it has resulted in the impounding of river water in the form of lakes and reservoirs. Conditions are most favourable in Tikamgarh district where tank irrigation plays an important role in agriculture. Higher relief in Panna, Hamirpur and Banda, however, does not favour their formation. Today, when canal
and well irrigation are gaining their popularity, tanks are becoming less important and the area under their command is shrinking. Their chief importance, however, is still recognised in raising the local water-table and indirectly encouraging well-irrigation. "Throughout the tracts where tanks exist, experience has shown that even when rainfall is not considerable, there is hardly single year in which the tank water has not been found useful."(1)

A vast number of tanks are found scattered throughout Jhansi, Tikamgarh, Chhatarpur and Panna districts. In fact every village has its own pond, not so much for irrigation but for the use of entire village community. Cattle drink water, villagers take bath and village maidens wash their grains in it. Water in them is, therefore, very dirty.

Of all the forms of tank irrigation in Bundelkhand, the most notable is from well-known lakes. Of these, four are in Jhansi and eight in Hamirpur district. These were constructed by Chandela and Bundela chiefs.

With the exception of Barua Sagar and Belatal, (which are fed by large streams; they have large storage capacity and extensive catchment area) these lakelets generally suffer

(1) Report of Indian Irrigation Commission, 1901-03 part I (General) p. 45
from lack of water in dry years as was experienced in the year 1900. The information regarding their gauges and volumes etc. has been given in the following table. \(^{(1)}\) The figures may be noted for the year 1900 in comparison with their corresponding figures at full supply.

**Table No. LVII**

Storage Capacity of Important Tanks in Bundelkhand

<table>
<thead>
<tr>
<th>Tank</th>
<th>Full supply</th>
<th>1900</th>
<th>Area (in 000 sq.ft.) at full supply</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gauge</td>
<td>Volume (million cft.)</td>
<td>Gauge</td>
</tr>
<tr>
<td>Bama Sagar</td>
<td>13.00</td>
<td>325.00</td>
<td>13.00</td>
</tr>
<tr>
<td>Pachwar</td>
<td>26.00</td>
<td>308.00</td>
<td>23.70</td>
</tr>
<tr>
<td>Magarwara</td>
<td>21.30</td>
<td>59.00</td>
<td>16.50</td>
</tr>
<tr>
<td>Kachreh</td>
<td>16.17</td>
<td>160.00</td>
<td>10.79</td>
</tr>
<tr>
<td>Kiratsagar</td>
<td>9.02</td>
<td>66.50</td>
<td>4.06</td>
</tr>
<tr>
<td>Madan Sagar</td>
<td>8.73</td>
<td>17.50</td>
<td>4.55</td>
</tr>
<tr>
<td>Bijnagar</td>
<td>12.25</td>
<td>189.50</td>
<td>5.05</td>
</tr>
<tr>
<td>Thana</td>
<td>15.46</td>
<td>112.50</td>
<td>10.00</td>
</tr>
<tr>
<td>Dasrapur</td>
<td>16.00</td>
<td>119.50</td>
<td>8.70</td>
</tr>
<tr>
<td>Tikamu</td>
<td>10.00</td>
<td>13.75</td>
<td>5.90</td>
</tr>
<tr>
<td>Belatal</td>
<td>7.50</td>
<td>353.00</td>
<td>7.50</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Adapted from Report of Indian Irrigation Commission, 1901-03 part I (General) p. 87
389. It may be immediately realised from the table that if a tank has to serve as a source of irrigation, it must have two main characteristics: (a) a good storage capacity and (b) an extensive catchment area to feed it.

Storage capacity of the tank depends upon its size and depth. Depth is certainly more important than its size. A shallow but extensive sheet of water is of less importance for irrigation because it provides conditions for greater evaporation. The loss of water from such types of tanks has been calculated as under:

- Cold weather 3" per month i.e. 12" for 4 months
- Hot weather 10" per month i.e. 40" for 4 months
- Monsoon 5" per month i.e. 20" for 4 months

Total ... 72" i.e. 6 ft.

The drainage area which feeds a tank is called its catchment area. It should be large enough to ensure its filling. But filling largely depends on the nature and amount of rainfall as also on the character of underlying rocks. It has been calculated (as per Binny's percentage formula (2)) that in Bundelkhand where the rainfall varies

(1) Manual of Minor Irrigation Works (C.P.A. Series No. 23) Government of India, p. 27
(2) Ibid. p. 19
from 30 to 50 inches and where the topography is also undulating, the 'yield' per sq. mile of catchment area comes to about 40%. This means that majority of the tanks in Bundelkhand always remain underfed leaving seasons of exceptionally heavy precipitation.

**Types of Irrigating Tank in Bundelkhand**

From the view point of irrigation, five main types of tank can be recognised in the area under study.

1. Tanks constructed purely for water storage and irrigation from them is rarely done. Almost every village tank comes in this category.

2. Submerging tanks are meant for temporary storage of water during the rainy season. Water is drained off during the beginning of cold weather and dry bed is cultivated for rabi crops. Pawa, in Talbehat pargana, is a good example.

3. Lakes and reservoirs in which water is stored primarily for irrigating kharif crops below their embankments are also found. After irrigation, rest of the water is drained off and their dry beds are cultivated without additional irrigation to the crops grown.

4. Fourth category belongs to the lakes and reservoirs which are fitted with sluices. Channels have been taken
out from them to irrigate areas adjoining the channels. These have been formed by throwing an embankment across the stream at suitable site. Pahuj, Dakwan and Gangau reservoirs belong to this class.

5. This category includes a large number of depressions in which flood-water is impounded during the rainy days and their water is used to irrigate surrounding fields with the help of swinging buckets. They are found in every village.

Major lakes, tanks and reservoirs of Bundelkhand

Barua Sagar

Situated twelve miles east of Jhansi, Barua-sagar is the most important lake of the region. It was constructed by Raja Udet Singh of Orchha (1705 - 1737). Canals from it were drawn by Mr. Clarke, an official of the Irrigation Department of British India in the last decade of nineteen century. With a catchment area of 74 sq. miles, it stores sufficient water to irrigate not less than 4,000 acres of land, but at present it irrigates about 1,000 acres or even less. Barua-sagar has given rise to a very rich and sturdy Kachhi community which grows vegetables for Jhansi group of towns.

Kachneh

It is found about four miles south of Nowgong.
Originally constructed by Chandel kings, about 1,000 years ago, its present dam was constructed by Raja Bir Singh of Orchha in 1600 A.D. Its catchment area is only 6 sq. miles and length of channels about 15 miles. It irrigates 700 acres of land.

**Pachwara**

With a catchment area of about 12.44 sq. miles and storage capacity of 300 million cft. of water, Pachwara lake was constructed by Mr. Stuart, the Secretary to the Government (P.W.D.) in 1868 to irrigate about 3,400 acres of land in Jhansi district. It, however, irrigates only about 700 acres of land at present.

**Magarwara**

Magarwara lake was constructed during the famine of 1868-69. It has a catchment area of only 3 sq. miles and irrigates about 200 acres of land.

**Belatal**

Situated 7 miles south of Kulpahar in Hamirpur, Belatal is fed by a number of seasonal streams. It sends distributaries of water-channel for a distance of 30 miles north-west. It irrigates about 400 acres of land.

**Maingawan tank**

This tank is situated south of Belatal and is
bigger than the latter in size. It sends off distributaries for a distance of 20 miles west of Belatal. It has been constructed in a natural depression caused by the surrounding hillocks in the east, west and north. Its channel irrigates the entire water-divide between Birma river and its right bank tributary in the Kulpahar pargana.

**Barwar lake**

This fine sheet of fresh water has been created by the interception of Lakheri nala by a long narrow and high quartz-reef west of Garautha. Its total area is about 5 sq. miles and it is fed by a big catchment area. It irrigates the whole of water-divide between Lakheri and Chhechh nadi, both of which are tributaries of River Dhasan.

**Madan Sagar**

It is a magnificent lake situated in Jatara tahsil of Tikamgarh district and commands an area of 2,000 acres. It has a good channel system and its waste weir is located in a saddle formed by two local hillocks.

**Other old lakes**

Among the other notable lakes are a group of lakelets around Mahoba town namely Thana, Bijainagar and Raipur sagar. All of these have sluice system. In southern part of Hamirpur district are Kirat Sagar, Dasrapur, Naigaon, Tikmau, Kalayan Sagar, Rahilia, Mahra, Telipahari, Pawa, Bilkhi.
Kabrai and about 20 more smaller sheets of water.

Projects of Post Independence Period

Lalitpur dam

Lalitpur dam was the first to be taken up and completed on Shahzad river, a tributary of River Betwa. Since irrigation by Betwa canal had gone upto 167,000 acres by 1945, its construction was necessitated to irrigate an additional area of about 40,000 acres in an attempt to raise about 8,000 tons of additional food grains. Its storage capacity is 3,900 million cft. Its main defect is that it covers a shallow depression between two higher grounds traversed by 1,250 ft. contour. Channels are being dug for irrigation.

Saprar Dam

As the prosperity of the area commanded by Dhasan canal was endangered by gradual reduction in the storage capacity of Pahari and Lachura weirs due to silting, Karanuncha village on River Saprar, about 5 miles south of Mauranipur, was selected as the site for a new dam. Its capacity is 3,400 million cft. of water sufficient to irrigate 40,000 acres of land and to produce about 10,000 tons of additional food grains.

Kabrai dam

Kabrai dam is near Nohoba town, it utilises the
waters of Magaria and Kulharni streams. The earthen dam is about 1½ miles long and 50 ft. high. This now commands about 40,000 acres of land between Chandrawal and Shyam nala north of Mahoba. This area did not have any means of irrigation before Kabrai dam was constructed. The wells were useless as the spring level was about 80 ft. deep. At present it irrigates about 4,000 acres of land around Mahoba town and 1,000 acres in Mahoba tahsil.

Matatila
Matatila dam on River Betwa in Jhansi district is the second biggest multipurpose project of Uttar Pradesh. The site of the dam is between two rocky ridges which close towards the valley of river Betwa flowing over gneiss basement. The bed of the river is full of rocky 'islands' through which it flows with sufferance. Base is, however, highly fractured and faulted so that leakage is the common defect. The reservoir has submerged about 10 or 12 sq. miles of area mostly in Madhya Pradesh.

The project has been completed at a cost of 4 crore of rupees to provide irrigation to 50,000 acres of land in 360 villages of Madhya Pradesh and Uttar Pradesh.

Canal Irrigation
Prior to 1880, there was no irrigation from canals in Bundelkhand. In some parts of Jhansi flood irrigation was
practised from streams by diverting their water. It was soon given up owing to the fact that the rivers formed deep valleys and lift or flow irrigation from them was not always easy.

Canals were introduced in Bundelkhand for the first time by British by utilising the main rivers of the region in order to protect it from the horrors of famines and droughts.

Today canals have assumed greatest importance as the chief source of irrigation. They irrigate about 620,000 acres i.e. 66.6% of the total irrigated area. They are the most popular source of irrigation in Jalaun, Jhansi, Hamirpur and Banda districts because a level or slightly undulating plain, with loose surface rocks, enable the construction of canals easy and cheap. Canals in Bundelkhand have been planned to irrigate fertile water divides of the northward flowing streams.

The direction of these canals has been kept in strict conformity with the regional slope from south to north. For that reason River Yamuna, which is the largest stream of the region, has not been tapped because it flows transverse to the general slope of the country. Moreover the level of River Yamuna is too low for the country south of it.

The principle of canal construction is to plan it in such a way as to serve large and agriculturally fertile areas...
so that its water is regularly utilised by the farmers. This basic consideration was kept in view when the streams were tapped in southern Bundelkhand for the benefit of the northern plain. In southern part of the region, hard surface rocks, high relief and absence of broad water-divides, do not permit the construction of large canals; here only small projects are possible.

**Important Canals of Bundelkhand**

**Betwa Canal**

Betwa canal was the first protective canal in India designed primarily to protect the triangular water-divide between River Pahuj and River Betwa in Jhansi, Jalaun and Hamirpur districts from recurrence of droughts and famines. The original proposal for this project was submitted in 1868, but it was accorded sanction in 1881. The work was completed in 1887 when it was commissioned for use. This canal was taken out from the left bank of River Betwa from Parichha, 14 miles south of Jhansi, where the river flows over a solid gneiss structure and impounds 1,700 million cft. of water with the help of a weir that connects both banks of the river through a rocky island.

The main canal runs parallel to Jhansi-Kanpur rail-road and after a distance of 12 miles, bifurcates into two branches i.e. Kuthond and Hamirpur branches. The former, with many
distributaries, serves the water-divide between River Pahuj and Noon-nala in Jalaun district and the latter irrigates most of the region between Noon-nala and River Betwa as far as its confluence with River Yamuna near the town of Hamirpur.

The past records show that irrigation from Betwa canal in this whole tract was limited to 3 or 4% of the total cultivated area from 1885 to 1895, but the famine of 1897 changed the whole picture when it irrigated about 23% of the total cultivated area. Even the peasants of black soil tract (in Konch tahsil) who were at first averse to its use started irrigation from it. Further impetus to Betwa canal was given by supplementing the Parichha reservoir by additional storage at Daulkwan, 25 miles further south. Its capacity was 350 million cubic feet of water for use in Betwa canal. This greatly improved the discharge capacity of the canal from 300 to 600 cusecs. At present the whole system irrigates about 3 lakh acres of land. It commands an area of 9 lakh acres of which it is capable of irrigating 7 lakh acres only.

**Ken Canal**

The service rendered by the Betwa canal in the famine of 1896-97 was very great. Encouraged by its results the survey of the area for the proposed Ken canal was speeded up. This project was originally mooted out in 1870 wherein provision was made to construct two reservoirs, one at Gaurshedpur
and the second at Kharauni. The former was approved and completed in 1873. In the year 1874-75 a revised scheme was submitted by Richardson for raising the Gaurshedpur weir from 50 to 68 ft., but it had to be postponed on grounds of financial policies and absorption of the government in improving Betwa canal to make it more efficient system.

Bariarpur was selected as the best site for Ken canal headworks. Here the river flows over a rocky bed which is 1/3rd of a mile broad with about 26 ft. high banks. Here the length of the weir is 2,290 ft.; it is 20 ft. above the normal water level and the head of the canal is 9 ft. below the crest of the weir. Iron shutters fitted at the top of the weir enable water to rise by 8 ft. more and the storage capacity of the reservoir consequently increases from 180 million cft. to 426 million cft. of water. The weir is fitted with sluices capable of discharging 2,000 cusecs to prevent any accumulation of silt.

Like the Betwa canal the supply of water from Ken canal was also felt inadequate. It was later strengthened by constructing a huge reservoir (capacity 5,000 million cft.) near Gangaw village in Chhatarpur district.

From Bariarpur, the headworks of the Ken canal, the main channel runs in the north-east, parallel to the right
bank of River Ken. It finally bifurcates into western branch known as Banda canal and eastern branch called the Attarza canal; former runs along the water-divide between River Ken in the west and Garala nadi in the east and the latter serves the water divide between Garala nadi and River Baghain. Thus, most of the Trans-Ken tract is irrigated by Ken canal in Banda, Baburu and Naraini tahsils. At present it irrigates about 1.73 lakh acres of land.

**Dhasan canal**

A rocky ridge across the River Dhasan, just south of Lahchura ghat, some 9 miles east of Mauanipur, is the site of the weir and the headworks of Dhasan canal. It takes off from the right bank of River Dhasan and commands the entire watershed between River Dhasan and its tributary Birma nadi. After a course of about 20 miles it divides into three main channels i.e. (a) the western or the Islampur branch which irrigates area just east of River Dhasan and further south of River Betwa, (b) the central or Jalalpur branch and (c) the eastern or Maudaha branch. Both these latter branches irrigate the entire area east of Birma nadi.

Dhasan canal system, as a whole, commands about 1.7 lakh acres of area but it irrigates averagely about 68,000 acres only. Rest of the commanded area is ravine land of Dhasan, Betwa and Birma streams.
The average area commanded and irrigated by each of these canals has been shown in the following table:-(1)

<table>
<thead>
<tr>
<th>District</th>
<th>Canal</th>
<th>Culturable commanded area (in acres)</th>
<th>Normal area irrigated (in acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jhansi</td>
<td>Betwa</td>
<td>1,43,417</td>
<td>33,769</td>
</tr>
<tr>
<td></td>
<td>Pahuj and Garhmai</td>
<td>33,218</td>
<td>9,078</td>
</tr>
<tr>
<td>Jalaun</td>
<td>Betwa</td>
<td>7,18,536</td>
<td>2,36,016</td>
</tr>
<tr>
<td>Hamirpur</td>
<td>Betwa</td>
<td>46,790</td>
<td>9,533</td>
</tr>
<tr>
<td></td>
<td>Dhasan</td>
<td>2,40,111</td>
<td>92,252</td>
</tr>
<tr>
<td>Banda</td>
<td>Ken</td>
<td>4,70,575</td>
<td>17,13,000</td>
</tr>
</tbody>
</table>

Effects of Canal Irrigation

There is absolutely no doubt that canal irrigation is very much responsible for stabilization of agriculture in Bundelkhand. It has provided necessary protection to the regional crops for which they were planned and executed. In the pre-canal period, area under cultivation greatly fluctuated in each district of Bundelkhand during droughts and famines.

(1) Courtesy: Superintending Engineer, IV Circle, Irrigation Works, U.P., Jhansi
In the famine of 1896-97, for example, the cultivated area was nearly a million acres below the corresponding area for the year 1882-83 in U.P. Bundelkhand. (1) As a result of such extreme fluctuations the agricultural land had little economic value. But with the introduction of canal irrigation harvests were assured so that the value of land greatly increased. Not only was agriculture stabilized here but the area under cultivation also increased. The total cultivated area in U.P. Bundelkhand in the year 1882-83 was only 33 lakh acres which in 1947-48 became 36.6 lakh acres with additional 3.4 lakh acres as double cropped area owing to irrigational facilities provided mainly by canals. In the year 1963-64 the cultivated area stood at 43 lakh acres and the double-cropped area at 4 lakh acres. Irrigation by canals also introduced several changes in the crop pattern and crop rotations in Bundelkhand. Rice which was unknown in dry parts of western Jalaun is now grown all along the canal zone. Sugarcane has now been widely introduced only because of assured water supply from canals. Cotton has, however, completely vanished throughout the region because soil moisture has increased.

Another effect of canal irrigation was felt in bringing new areas under cultivation and raising the out-turn of food-

(1) Report of the Irrigation Commission, 1901-03, Pt. II (Provincial) p. 183
grains. As a whole production per acre has increased in the region. 'Experiments reveal that two waterings of irrigation raise the yield to twice the dry yield while a single watering improves it by 1.5 times.' (1) But at the same time certain problems have arisen from canals and irrigation from them. These may be summed up as under:

**Water-logging and Soil erosion**

At various places, such as in Jalaun district, natural drainage has been interfered by the canals and during the rainy season a sheet of rain water moves through certain villages where sheet erosion has increased. From the village Bichauli (district Jalaun) there passes a channel-less sheet of water which comes from Tihar-Rampura tract every year. Water-logging at several places has thus increased. This is the result of insufficient survey of local slope while constructing the drainage channel from this area.

**Deterioration of Parus soils**

Canal water is highly charged with sand. Therefore, parus soils, which are already very sandy in texture, have deteriorated in fertility at various places.

**Problem of 'Ooha'**

The canals have raised the regional water-table considerably (10 to 15 ft.); as a result of which areas, all


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J. P. Saxena
along the canal zone, suffer from 'Ogha' i.e. excessive soil-moisture (by capillary system) which has become a serious problem for the peasants. Throughout Bangra-Madhogarh Rampura and Kuthond tract 'Ogha' has been chiefly responsible for a complete abandonment of wheat and gram as rabi crops. Rising water-table has also affected the character of underground water which has now become 'hard' owing to the solution of lime and other salts in it. As water of 'neutral type' is alone fit for irrigation, many irrigation wells have been thrown out of use.

**Other sources**

The 'other sources', even when put together irrigate only 0.32% of the total cultivated area in Bundelkhand. These sources include many local devices by which irrigation is done.

Previously tank irrigation was also included in this category but now it is separately reported in official records.

The most popular devices used in the lift-irrigation are 'Dauri' and 'Thekali' systems.

In 'Dauri' two persons are required to lift water to a height of 3 to 4 ft. by means of swinging basket. About 12 gallons of water per minute is lifted by this method.
In 'Dhekali' system, use is made of the principle of lever with suspended fulcrum and a counter-weight; about 5 to 8 gallons of water per minute is lifted by this method.

'Mot' or 'Charas' involves the use of a big leather bucket and a stout rope pulled by a pair of oxen. It is used in the wells in which water is found at a depth of 20 to 30 ft. only. The discharge capacity of the 'mot' varies from 1,000 to 1,500 gallons per hour and it would take one day to irrigate 1/3 or 1/4 of an acre of land. Its working cost is Rs. 5 to Rs. 6 per day.

'Rehat' or Persian-wheel is more efficient method than the 'mot'. About 1,500 to 2,000 gallons of water per hour can be lifted up from a 30 ft. deep well with the help of animal-power. But its initial cost is high, about 600 to 800 rupees. Its working cost is about Rs. 25 per acre.

Among the flow-irrigation, channel is dug out along the boundaries of the field and canal water is allowed to flow through it for diverting it into the field from some suitable corner.

Flood irrigation by diverting the stream water directly into the field has now been completely given up in Jhansi district.
Water requirement of some crops

In general the water requirement of the crop depends upon (a) climatic conditions, (b) soil texture, (c) drainage conditions, (d) sub-surface water-table (e) use of different kinds of manure, (f) crop rotation and (g) quality and cost of water. Experiments have, however, generalised the water requirement of certain crops noted below:

Rice

Rice plant requires periodical waterings at three stages. The first is the seedling stage covering about 10 days; second is the pre-ploughing stage lasting about 25 days. Finally, the plant must be watered when the ground is being ploughed, i.e. for 5 to 7 days. The standing water increases the height of the plant by producing conditions of temperature suitable for seedlings to grow. The fields should, however, be cleared of water afterwards, otherwise tilling suffers. Investigations show that flooding the field after transplantation for about three weeks, followed by subsequent dewatering is in fact more beneficial to the plant. The average "duty" varies between 60 to 70.

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(2) 'Duty' has been defined as the water requirement of a crop. 'Out let duty' refers to the area irrigated per cusec of water issued at the out let. One cusec is equal to about 22,000 gallons of water flowing per hour.
Wheat

Pot-culture experiments prove that minimum water requirement of wheat is 8.5 inches only. But in fields it may vary according to the nature and amount of seasonal rainfall. If it rains adequately in September/October and December/January there is no need for extra irrigation. If not then 60,000 gallons of water per acre, applied twice, give the best yield. These results are also applicable to most of the other rabi crops.

Sugarcane

Minimum water requirement of sugarcane is 45 inches, though it varies slightly with the species of the cane. Roughly 80,000 gallons per acre give the best result. Frequency of watering is more important than depth of watering. Most critical period in the life-cycle of the plant extends from middle of May to the end of June. It requires 5 to 7 waterings in all. Five inches deep irrigation at two-week interval gives the maximum yield of sugarcane.

Cotton

Cotton requires 24 to 28 inches of water. First irrigation should be applied 3 to 4 weeks after sowing. No irrigation is necessary after 15th of October except for late maturing varieties. Its 'duty' has been found to be about 100.
These experiments point out to the fact over-irrigation is not only unnecessary but also harmful and hence it should be avoided. The water so conserved should be used for bringing more fields under irrigation.

_Economics of Irrigation: Water Rates in Bundelkhand_

One of the chief economic factors in irrigation is concerned with the resourcefulness of the peasants to pay the charges for the type of irrigation they practise in their fields.

Now a days canals provide water to the farmers by metric system i.e. with a fixed measurement at the out-let, but in practice, farmers use as such water as they like. However, old methods of water rates such as 'occupiers rate' and the 'Abi rates' have been given up.

In M.P. Bundelkhand current water rates, in force from 1961 also take into consideration the type of crop raised on the irrigated field. The rates are as under :-

1. For Paddy zone:
   - Paddy, Rs. 8/- per acre for long term agreement.
   - Wheat, Rs. 4/- per acre for one year agreement.

For Wheat zone:

Paddy, Rs. 10/- per acre for one year agreement.
Wheat, Rs. 7/50 per acre for one year agreement.

Water rates for second crops in the same field at half the above rates.

Sugarcane: Rs. 20/- per acre for one year agreement.

For lift irrigation charges should be on volumetric basis i.e. Re. 1/- for 15,000 gallons; for flood irrigation by regulators i.e. Rs. 2/- per acre.

In Uttar Pradesh water rates charges on Betwa and Ken canals are:

Kharif (Paddy) Rs. 10.00 to Rs. 14.00
Rabi (wheat) Rs. 2.00 to Rs. 6.00
Sugarcane Rs. 6.00 to Rs. 16.00

For lift irrigation charges are not fully known but for paddy it is Rs. 1.00 for 11,000 gallons of water lifted up by diesel engine and Re. 1.00 for 16,000 gallons by electric engine.

Since the working cost of well and tank irrigation is less than that of canals, peasants still prefer in many parts these sources for irrigating their crops. However, the ease with which they can obtain water at the time of need is also very important factor.
The economics of irrigation can also be examined from the point of view of additional yield of food-grains. The extra yield from irrigation for food crops is approximately 5 maunds per acre. The cost varies from Rs. 100/- to Rs. 150/- per acre. The increase is several times more where rainfall is low and uncertain as in western part of Bundelkhand. Even the most expensive method of irrigation would not cost more than Rs. 30/- per acre. This would mean a net saving of from Rs. 70/- to Rs. 120/- per acre for cultivator. Any type of irrigation is thus economical in terms of the cash value of extra yield of crops.