EARLY IRRIGATION UNDER THE BRITISH, 1843-1932

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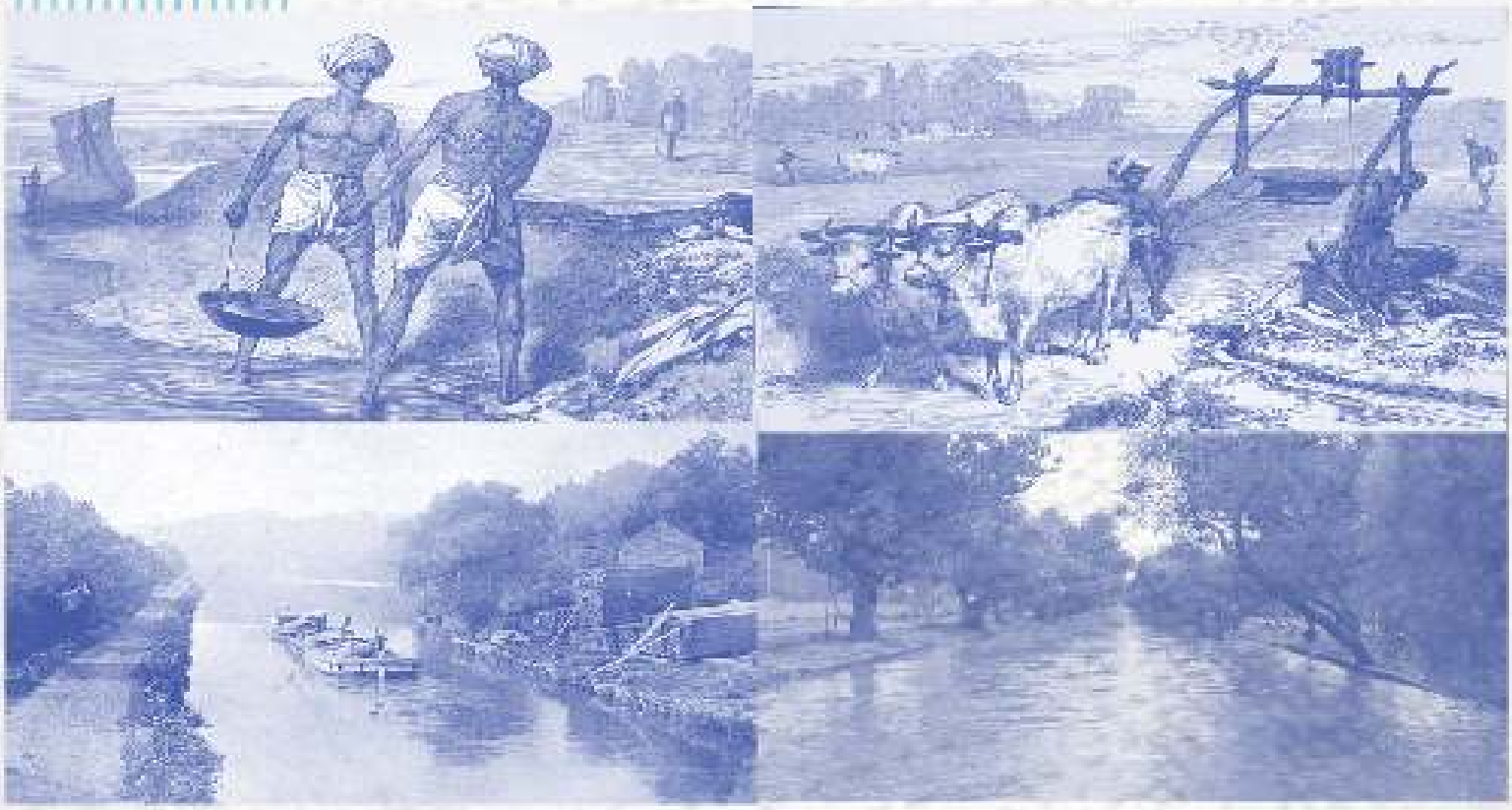

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The British on conquest of Sindh inherited canal net work which already was not in good shape, but the change also brought an immediate decay of the system, as Charles Napier's officers took time to understand that canal clearance was an important annual operation, without which canals wont carry full discharge and would even choke.

Sir Charles Napier who had conquered Sindh in 1843 organised a combined Canal and Forest Department and put it under charge of Lt. Col. Water Scot of Bombay Royal Engineers but no useful work could be done by this engineer as the officers given to him incharge of canals were mostly non-engineers and as a result the department was abolished in 1849, he however studied the then existing canal system, identified the main defects of the old system and made certain recommendations for its improvement but no progress was made beyond this. The main point of this report worth mentioning is his recommendation of the proposed Rohri-Hyderabad canal which he considered neither technically feasible nor economically viable.

One of the early surveyors in the department was Richard Burton, (Later on Sir), who in his off duty hours, kept studying what can be termed as anthropology of Sindh and was published in a number of reports. He also developed a through knowledge of working of canals as is discussed in his various writings.

John Jacob incharge of North Western Frontier (Jaccobabad) district, had improved irrigation in his district between 1843-1951 and as per his advice, Barle Frere the Commissioner in Sindh, organised canal department under Col. Blois Turner.

General John Jacob not only improved the then existing Begari Canal of Upper Sindh but the existence of Desert Canal, then called Maksudabad the second biggest canal of Upper Sindh, is due to him. It was he who got the project of Desert canal prepared and forwarded it to the Government in year 1855. The project however could not be carried out until year 1873.

J.G. Fife was appointed as Superintending Engineer, Canal Department in 1855 and in 1859 he connected the Eastern Nara Canal with the river Indus, by

a link canal up-stream of Rohri. This link served up to 1932 and is still capable of bringing supplementary supplies to Nara Canal, if needed any time.

The contribution of this celebrated British engineer towards the canals system in Sindh is such that he is rightly remembered even today as the Father of Irrigation System in Sindh.

Fife for the first time in the irrigation history of Sindh fully understood defects of inundation canals and proposed solutions in form a scheme for perennial and assured irrigation water supply to Sindh. In his a scheme which is predecessor of (Sukkur Barrage site), for taking one canal (Rohri to irrigate the left bank and enter Phulelli canal near Hyderabad and another canal from Sukkur to Manchar lake via Western Nara (to become predecessor of Dadu and Rice canals); a weir at Jerruck for a right bank canal (predecessor of Kalri Baghar) and a canal on left bank (a predecessor of Pinyari and Guni canals). He also suggested fifth canal from Eastern Nara to Wanga Bazar (predecessor of Mithrao canal). Fife's report was rejected by the Bombay Government. Even if it has been accepted, there was lack of experience of construction of a barrage of this magnitude on any river similar to the Indus in width, depth and discharge, the equipment to execute.

The works did not exist. Portable for mobile cranes, drag lines and clam-shafts were another 40 years away, and diesel and petrol engines had yet bee developed, to give required mobility to equipment for construction. Executive machinery as used for the first time for the construction of Suez Canal by the French engineers in 1969 was not even dreamt of at the time of Fife's proposal in 1859 A.D. If the proposal had been accepted, yet it would have taken at least 30 years to design, and build the equipment and construction completed at a cost higher than in 1932, as by the later date all kinds of excavation machines where already in use.

The great trigonometrically Survey of India which produced contour maps of Sindh from 1860 A.D., onwards brought an unusual advantage to the canal improvement. The engineers could foresee the slopes and improve the inundation canals and their branches, leading to improved water courses of the farmers. The improvements carried out form 1855-1904 are detailed below:

Right Bank of Indus.

In supper Sindh, the Maksuda Wah or Desert Canal Begari and Sindh were the main inundation canal systems. The desert canal then was only 35 miles in length which now is about 63 miles long. The Begari Canal whose year of origin may go back to Soomra-Samma period was only 40 miles in length, its branches being Nur Wah, Sone Wah, and Mirza Wah. Sindh canal was in an old

natural stream with head which was never a successful one till it was provided with new head by General Fife.

Nara Canal System

Soon after taking over the charge his attention was drawn to the failure of Nara River in bringing supplied for irrigation in Thar Parkar District. The Nara River which formed the part of Drishadvati-Sarsuti-Hakra System got dried up and general impression prevalent then was that certain influential people/tribes cut off the supplies by bounding Hakra and diverting the water for their use. The matter was investigated and it was established that no artificial diversion had taken place and that the supplied had been cut off on account of geological changes much in the north some 4,000 years ago. In order therefore to meet the situation Col. Fife prepared the project of link connecting Nara River by an artificial channel with river Indus upstream of the gorge. This link was called the Nara supply channel which was opened in year 1859. The off take of supply channel being upstream of Rohri gorge having the advantage of levels in low flow periods was expected to work as a perennial channel.

The project of right bank canal from Sukkur though to a much reduced scope was accepted and work sanctioned in year 1861. Similarly the Mithrao canal project was also accepted and approved but the project could not be completed before 1879.

Rohri Canal

The proposed Rohri Hyderabad canal though not considered then for implementation was incorporated in the Sukkur Barrage Project and is now known as Rohri Canal the premier canal of Sindh with hardly any parallel in the country.

Jamrao Canal System

An other important canal project initiated by Col. Fife was the Jamrao Canal Project which envisaged the construction of canal system Ex-Nara River for providing perennial irrigation. The project proposals were submitted in year 1860 but which competing projects like Rohri Hyderabad Canal, Sukkur Canal, Mithrau Canal Project, the Jamrao canal project could not be pushed through and had to wait till year 1894 when the project was under taken and completed in 1899 and inaugurated on 24th November, 1899.

Reverting back to Jamrao canal project, it may be mentioned that it comprised of construction of a weir across river Nara with Jamrao Canal off taking from the bye-pass channel with gated under sluices and the system being operated on the still pond principle. Thus Jamrao was the first ever weir controlled perennial canal in Sindh.

1902-1904 after the completion of Jamrao Canal project the major new canal projects worth mentioning that were under taken were those of Nusrat Canal and Dad Wah, which were constructed between 1902-1904. The remodeling of Desert Canal was also under taken in this period.

Unar Canal

From 1884-1894, the largest canal work under taken was the construction of Unar Wah on the Right Bank of Indus in Upper Sindh for irrigation of lands beyond the irrigation scope of Desert Canal in the North and Begari Canal in the South.

Dhamrao and Prichand

The Similar canal projects namely Dhamrao and Prichand were also carried out in year 1894. The Dhamrao canal now forms an important branch of the Rice Canal of Sukkur Barrage. The Prichand canal was converted as an escape and is functioning as such.

There were however quite a few small irrigation projects some for new canals and some for improving/remodeling the existing ones under taken from 1904 to 1919. when the Sukkur Barrage Project was sanctioned , one of the new canal projects worth mentioning was the Chol Branch on the right bank off taking from the approach channel of Begari Canal.

There were in Kashmore area two more canals though not as big as Maksud Wah, Begari or Sindh which in the British days were named as Jacob Wah and Brig Wah. These two canals were mainly used for filling Sindh Dhoro, an old bed of Sindhu, yet they did provide irrigation supplies to the farmers of the area. South of Sindh Wah there were smaller canals like Sherwah (now Sherkot Branch), Rajab, Ghitti (Gatwah) and Grang canals all Ex-Indus. Garang is the only Inundation canal in Sindh even after the construction of three Barrages.

The Manchar Lake.

Manchar Lake has been one of the major sources of irrigation water supplies from times of Mohen-jo-Daro Civilization or even earlier *i.e.,* pre Amrian times. It was a beautiful lake during summer season of good precipitation. It spread over 20 miles in length, 10 miles in breadth but in winter it shrunk to an area of about 10 miles in diameter. It was quite a deep and vast lake in the 15th-18th centuries.

The lake provided extensive irrigation in Khabrot, Bubak, Aktar, Supar, Shah Hassan Jhangara area. Western Nara entered the Lake at its northern tip

whereas Aral Canal fed it from the southern tip. The flow from Aral was more dependable and larger in quantum than the one from western Nara. The lands on the periphery of lake after evacuation at the end of flood season were cultivated with bumper Rabi crops, though in Kharif too people had their canals and Karias leading form Manchar Wah to their far off fields.

Manchar was also an important source of food in the form of fish and hundreds of boats were engaged in catching the fish and trading it in far off places.

In Sukkur Barrage Project the lake was provided with an embankment called Manchar Containing Bund 20 miles in length from Aral to outfall of M.N.V Drain.

In Manchar-Sehwan-Jamshoro area there were besides West Nara 37 Nos. Canals having total length of 135 miles, Phito, Danister, Karo, Sada Bahar being the important feeders tapping Indus.

Larkana Area

The Larkana area on the right bank of Indus then called Chandka was popularly known as garden of Sindh. It was irrigated by two major canals namely Western Nara and Ghar, which originally were the major streams of river Indus but, reduced, in size due to situation.

West Nara the biggest of the canals was quite tortuous in its course and after passing through present Larkana and Dadu districts joined Manchar Lake. It was navigable during abkalani period and the boatman preferred to move along Western Nara than the main Indus and there was quite a sizeable boat traffic adding to the trade and business and prosperity of the people.

The other major canals was the Ghar canal which too was as tortuous in course if not more than the great Western Nara.

In addition to Ghar and Western Nara the third important canal system was named as Wahur Wah which took off from Indus about 30 miles south of Larkana and was over 30 miles in length and 80 ft. wide at the mouth, it joined back the Indus near Sita. Marni, a branch of Wahur Wah was 15 miles in length. The total system comprised of 566 miles.

Thatta Area

Present Right Bank Command of Kotri Barrage. The southern delta region of Indus was intercepted by numerous creeks or branches of Indus the major being Juna, Richal, Phitti, Hajamro, Kakri Wari, Khedawari and Gharo. The

Gharo Branch was named after village Gharo which was-is situated on its right bank. There were 18 main feeder canals tapping Indus at different points and 31 channels big and small branched off from these feeder canals and provided irrigation supplies.

Of the 18 feeder canals Baghar (Baghar) Kalri, Ochito and Sian were large in size. These were more of bye-rivers rather than canals from any standard. Baghar was the western branch diverging a little to the south of Thatta and having numerous branches. It existed even in seventeenth century also and was major stream then navigable as far as Lahari Bunder, the principal poet to Sindh. In 1840 this major branch of Indus got silted at its mouth with the result that it ceased to be a perennial channel.

Ochito (Hajamro) was comparatively a small channel. The Sian was the upper part of Hajamro Branch of river was on off shoot of Sita or great eastern channel of Indus. It was connected with sea and was navigable. It was through this channel that Sir Alexander Burns and party taking horses for Raja Ranjeet Singh passed on their way to Punjab. In 1845 Hajamro got reduced in size and was hardly navigable even by small boats.

In all, there were 29 canals/streams that took from Indus on right bank below Kotri. The total system comprised of 360 miles of canals.

Indus Left Bank

Present Guddu Left Bank Command, The principal canals that existed on the left bank of Indus in present Sukkur District (Guddu Canals Command) were Dahar Wah, Imam Wah, Masu Wah, Maharo, Lundhi, Bago Wah, Mian Wah, Dengro, Ganj Bahar, mahesro, Korai, Kanib Wah, Umerkhas, Arore Wah and Mir Wah. In addition to these feeder canals which tapped the Indus, there were other major branches namely Sadakur 26 miles Ex-Aror, Nihal Wah (8 miles) and Raj Wah (8 miles) both Ex-Dahar Wah and Kalian Wah Ex-Janib. There were 26 branches canals Ex-Dengro, 14 from Lundhi and 12 from Korai.

Eastern Nara Canal.

The first principal canal on the left bank called Eastern Nara was originally the lower part of Drishadvati-Sarsuti-Hakra System of rivers.

Its waters started reducing in 2,000 B.C., due to aridity but. It kept flowing with low discharges for some centuries. During the "Climatic optimum" (900-1300 B.C. Flowed regular in summer), thought this time most of water came form spills of the Indus and the Sutlej. The Eastern Branches of the Indus also joined it below Badin from around 900 A.D. to 1758 A.D., spread out in wide

sheets of water. Nara then a river and now a barrage canal possessed and still possess all the characteristic of a river, with a very tortuous course, twin and some-times triple channel flow. It waded its way down to Thar Parkar District and ultimately joined Dhoro Puran and then to sea.

Khairpur Area.

The Khairpur area was fairly well watered by five canals having their mouth Ex-Indus as well as from eastern Nara. The Canals were Mirwah (06 miles length and 90 ft. wide at head) Nara Wah (32 miles long and 60 ft. wide) Abul Wah (28 miles long 60 ft. wide) the Main Wah (16 miles long and 30 ft. wide) and Sahrowah. Mir Wah which was the largest of all bad several cuts which supplied water to t eh valleys in the sand hills where Barji and Jawar were grown in abundance.

Nawabshah District Area.

There were in all 21 feeder canals big and small tapping Indus at various points. The important ones were Naulakhi (25 miles in length 42 ft. wide at head), Nasrat (30 miles long 32 ft. wide) and Dad Wah (33 miles long), in all there were 74 channels big and small about 400 miles in length.

Naulakhi was one of the oldest canals and was probably excavated during the Samma period. Nasrat canal got excavated by Nasrat Khan Chandio during the rule of Mian Noor Mohammad Kalhoro. It had its mouth was ex-bye-river (community known as Dhandh) called Gangam. Murad Branch (25 miles long) Bagh Wah 27 miles long and Piroz Wah 24 miles long three important branches Ex-Naulakhi excavated by Murad Khan Kalhoro, Baga Sial and Pairoz Khan, three noblemen of the court of Mian Noor Mohammad Kalhora.

Hyderabad District, Hala Hyderabad Area

This tract was irrigated by a net work of canals taking off from four river Gharss/(abandoned channels) namely Rana, Khanot, Mahmuda, Gahot, the supply in Mahmuda being perennial. The canal system comprised of 95 canals big and small has a total length of nearly 1100 miles.

Tando Muhammad Khan area.

The Canal system in this area (excluding Tando Mohammad Khan and below) comprised of 43 canals about 80 miles in length out of which 4 were main feeders tapping the Indus. These were Lakhir Wah (5.0 miles long Ex-Indus Ghalain), Fuleli (old) (35 miles long Ex-Indus Ghalian), Fuleli (New) (3 miles long Ex-Jamshoro) and Chandan Dara (1 mile long Ex-Jamshoro).

Present Kotri Barrage Command Area on the left bank.

Tando Muhammad Khan Area – There was on extensive irrigation system in this area comprising of nearly 100 canals large and small. Guni was the largest of all irrigating vast tracts. As many as 53 branches and sub-branch canals extending over a total length of 566 miles took off from Guni Wah.

Another important canal was the Gajah canal, which in fact was continuation of old Fulili. It was a 45 miles long canal and the system comprised of 11 branch/sub-branch canals having a total length of 78 miles. Iamawah (40 miles), Ali Bahar (7,5 miles), Pandhi Wah (6 miles), Lundo (5 miles) Handeehar (6 miles), Ghar Sharakat (5 miles) and Jhur Wah (4 miles) and Nasir Canals also carried sizeable boat traffic.

Shah Bandar Area

The Shah Bandar tract (South of Tando Mohammad Khan Area) was much intersected and cut by numerous creeks and channels and its southern area was marshy, unfit for cultivations. The largest of the creeks was the old bed of the Pinyari or Sir River. It ran inland for about 60 miles as far as Moghulbin (Jati) where it was stopped by a very large embankment constructed by Talpur in year 1797. Below this bank, Pinyari was navigable to Sir Month. During some years of high inundation the volume of water in Pinyari increased to an extent to necessitate some water being let out to the old and new salt water channels below the bund. If the northern parts (Jati area) it was called Gungro.

Two channels, the Adhiari and Sir were quite board and deep having a minimum depth of 20 feet. The Mal and Mutri though originally river channels were reduced in size to that of some big canals. They received water during inundation only but the supply went on declining and in year 1865 their mouths had silted to an extent that they received only a little supply. There were in all 152 canals big and small having total length of 804 miles. The Pinyari was the largest main feeder with a large number of branch / sub branch canals taking off from it. The other important feeder canals were (1) Ali Bahar (2) Gang Bahar (3) Mulchand (4) Bara Gazo (5) Sahtah (6) Ghar (7) Khanot (8) Hassan Ali (9) Eivet Mal (10) River Mutri.

In addition to the 10 feeders canals mentioned above, which tapped the Indus there were 30 more small canals which took off direct.

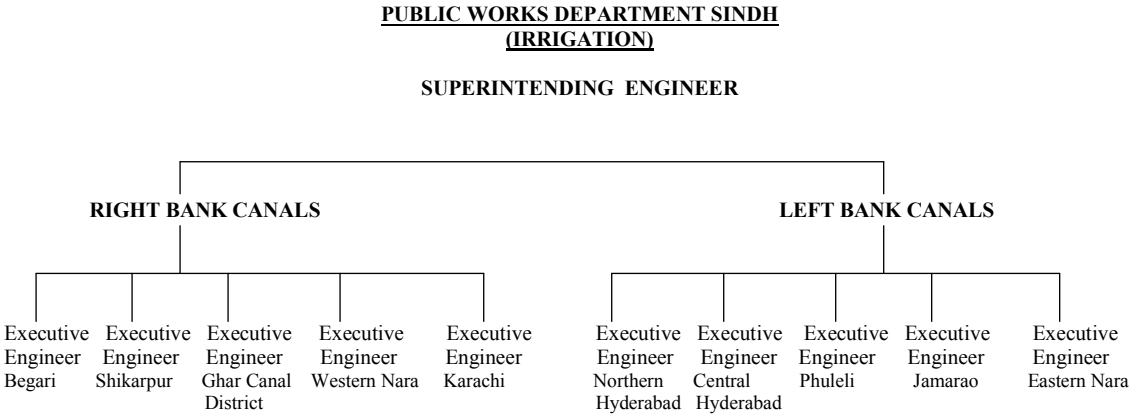
Thus there existed a large network of inundation irrigating canals on both banks of the river.

The excavation of water courses and canals became easier and large scale improvement works were carried out from time to time on the abandoned

rivulets to convert them into channels and give them some geometrical shape. No doubt large scale works involved in straightening the alignment of these natural rivulets by removing links and curves was not so possible. Substantial effort involving use of human and donkey labour has been put in from time to time to sustain the old channels or to create new ones for meeting the irrigation requirements of the people in different periods.

There were however quite a few small irrigation projects some for new canals and some for improving/remodeling the existing ones under taken from 1904 to 1919. when the Sukkur Barrage Project was sanctioned, one of the new canal projects worth mentioning was the Chol Branch on the right bank off taking from the approach channel of Begari Canal.

By 1904, the structure of the irrigation department (A wing of Public Works Department) was already functioning efficiently and is given in chart below:



Below is the list of inundation canals as existed in 1904/5 under each system of above 10 canal districts headed by an Executive Engineers.

These canals are also shown in irrigation map for 1901

1. Begari Canal District

Canal	Discharge Cusecs	Cultivation Acres.
* Desert Canal or Shahi Wah	4,255	190,000
* Unhar Canal or Unhar Wah	1,708	214,000
* Begari Canal.	6,745	276,000
* Adiowah	173	-
* Nine River Canals from various dhands.	-	2,400

2. Shikarpur Canal District

Canal	Discharge Cusecs	Cultivation Acres.
* Sher Wah	-	5,426
* Dahar Wah	-	45,177
* Mahi Wah	777	29,356
* Masu Wah	531	17,171
* Maharo Wah	-	5,463
* Lundi Wah	-	2,000
* Dengro Wah.	-	9,000
* Mahesro Wah	-	3,500
* Janih Wah	-	800
* Mir Wah	-	900
* Sindh Canal	1,613	91,956

3. Ghar Canal District.

Canal	Discharge Cusecs	Cultivation Acres.
* Sukkur Canal	-	93,455
* Ghar Canal System	5,288	
* Ford Wah	3,489	505,649
* Nusrat Wah	707	

4. Western Nara District

Canal	Discharge Cusecs	Cultivation Acres.
* Western Nara including its	4,565	-
* New feeder and	1,625	-
* Prichand Canal Feeder	1,600	-
	Total 7,789	
* Aral Canal	-	8,136
* Danster Canal	-	2,917
* Manchar Lake when evacuated	-	20,750

5. Karachi Canal District

Canal	Discharge Cusecs	Cultivation Acres.
* Baghar	7,400	25,464
* Pinyari	4,500	79,168
* Kalri	1,000	12,011
* Sattah Canal	-	9,487
* Khanot	-	4,481

6. Northern Hyderabad Canal District

Canal	Discharge Cusecs	Cultivation Acres.
* Mahrab Canal	189	6,817
* Naulakhi	1,150	49,786
* Dambhro	343	12,420
* Dad	2,341	71,457

7. Central Hyderabad Canal District

Canal	Discharge Cusecs	Cultivation Acres.
* Minor River Canals	-	4,296
* Ren Wah	751	2,785
* Ali Bahar Kacheri	-	10,291
* Markh Canal	1,180	54,887
* Gharo Mahmudo	-	64,979
* Ghalu Canal.	647	35,742
* Nasir Wah	-	33,834
* Sarfraz.	399	27,344

8. Phuleli Canal District

Canal	Discharge Cusecs	Cultivation Acres.
* Phuleli (Perennial).	11,000	303,512
Minar River Canals		
* Hassan Ali	489	1,129
* Khair Wah.		2,096
* Dhadhko Wah		1,634
* Mulchand Canal		
* Chandan		
* Mirwah		
* Wasing Wahy.	-	5,994
* Nurwah		
* Khokharwah.		

9. Jamrao Canal District

Canal	Discharge Cusecs	Cultivation Acres.
Jamrao Canal	-	272,267
With minor canals namely:		
* Nam Saheb		
* Dina.		
* Dolar.		
* Patoi		
* Dosn Dahraro		
* Mirpur		
* Bareji.		
* Dengan		
* Puran		
* Juriasar		
* Duleri		
* Silor		
* Bagi		
* Vlest Brown		

10. Eastern Nara Canal District

Canal	Discharge Cusecs	Cultivation Acres.
* Eastern Nara Canal (feeding Jamarao Mithrao Nara and other anals.	13,000 in Kharif 2,000 in Rabi	-
* Mithrao	2325 Kharif	150,811
* Nara		35,500
* Heran		1,925
* Khipro		3,523
* Thar	1,175	56,532
* Hiral		27,551

The above discharges and cultivation figures are for years 1902-3 to 1904-5.

The discharges are the average maximum for these years. Since discharges varied from day to day and year to year, the cultivation figures as well as discharges are indicative only, as in some years water in the canal flowed late and at other times receded early. There was uncertainly of acreage which would reach maturity for harvest. It caused partial failures of crops at least in each three years out of five on almost all canals. The poverty it created resulted in low standards, lack of education and superstition. The income to government from land revenue was low and government was not able to spend on education, health and agricultural services. This pitiable condition lead to loss of 40% lives in Sindh in 1917-18 influenza.

Embankments

The first experience on the flood protective embankments was done by John Jacob in Jacobabad District in 1852. His experience made it very clear that earthen embankments constructed some 5 miles or more from the main channel of the Indus could contend the river within the embankments and annual flooding of vast areas of plains can be averted.

Embankments and Irrigation District	Year of Start	Year of Completion
1. Begari.	1874-75	1879
2. Shikarpur	1869	1890
3. Ghar Canal	1874-75	1890
4. Western Nara embankments namely:		

Phulu, Gap band Nara Manjhand.		1890
5. Karachi embankments, consisting of		
Sando Hilaya Band		1887
Panah Baghar Band,		
Baghar Uchitio Band,		1900
Mulchand Shahbandar Band,		1880
6. Northern Hyderabad consisting of		
Naulakhi Damber top		1904
7. Central Hyderabad consisting of		
Ghalu Ali Bahar Band.		1894-95
8. Phuleli Bands consisting of:		
Golyan Band.	1895	1896
Jamshoro Band	1892-93	1901
Gidu Band	1894	1895
Malh Band	1895	1896
Hajipur Band.	1879-80	1895-96
9. Eastern Nara Canal consisting of:		
Rata Band		1854-58
Jababand		1873
Bokharo Bakar Band		1893

In 1864 the British Government had decided to float loans for irrigation project on the same lines as for railways. Such loans were advanced in Madras for the Madras Irrigation Company, guaranteeing 5% on capital invested. In case of Sindh such loans were never made available.

Table below gives year-wise figures of cultivation in Sindh on inundation canals for about 60 years. The area was doubled in first 27 years and further improvement did not take place as there was always a limit to the improvement in the inundation canal system. Only barrages on the Indus could increase more area.

Inundation Canal Cultivation (in millions of acres) under the British 1839-1931

Year	Kharif	Rabi	Total	Jagir.	Total
1973-74	1.196	0.223	1.419	Include in Kharif and Rabi figures	1.419
1974-75	1.224	0.373	1.597	-	1.597
1875-76	1.139	0.251	1.390	0.191	1.581
1876-77	1.291	0.419	1.710	0.136	1.846
1877-78	1.094	0.202	1.296	0.123	1.419
1878-79	1.333	0.552	1.885	0.131	2.016
1879-80	1.115	0.228	1.343	0.111	1.454
1880-81	1.173	0.156	1.329	0.164	1.493
1881-82	1.260	0.159	1.419	0.183	1.062
1882-83	1.282	0.226	1.508	0.165	1.673
1883-84	1.197	0.165	1.362	0.179	1.541
1884-85	1.354	0.232	1.586	0.197	1.783
1885-86	1.289	0.244	1.533	0.207	1.740
1886-87	1.408	0.186	1.594	0.221	1.815
1887-88	1.438	0.215	1.653	0.218	1.871
1887-89	1.649	0.239	1.888	0.231	2.119
1888-90	1.722	0.388	2.110	0.240	2.350
1889-91	1.597	0.385	1.955	0.248	2.203
1890-92	1.514	0.436	1.950	0.216	2.166
1891-93	1.633	0.535	2.168	0.231	2.386
1892-94	1.668	0.472	2.140	0.246	2.386
1893-95	1.621	0.772	2.393	0.243	2.636

Year	Canal Cultivation (in millions of acres)				
	Kharif	Rabi	Total	Jagir	Total
1895-96	1.522	0.319	1.841	0.526	2.097
1896-97	1.879	0.365	2.244	0.253	2.497
1897-98	1.995	0.530	2.525	0.281	2.806
1898-99	1.803	0.373	2.176	0.280	2.456
1899-1900	1.945	0.342	2.287	0.282	2.569
1900-01	2.168	0.545	2.713	0.331	3.044
1901-02	1.983	0.526	2.509	0.299	2.808
1902-03	1.939	0.385	2.324	0.302	2.626
1903-04	2.198	0.611	2.809	0.343	3.152
1904-05	2.090	0.524	2.614	0.310	2.924
1905-06	2.380	0.631	3.011	0.337	3.384
1906-07	2.377	0.785	3.162	0.324	3.486
1907-08	2.082	0.434	2.516	0.256	2.772
1908-09	2.361	0.668	3.029	0.316	3.345
1909-10	2.161	0.483	2.644	0.283	3.927
1910-11	2.287	0.545	2.832	0.290	3.122
1911-12	2.102	0.398	2.500	0.233	2.733
1912-13	2.334	0.440	2.774	0.265	3.039
1913-14	2.358	0.512	2.870	0.277	3.147
1914-15	2.302	0.732	3.034	0.315	3.349
1915-16	2.131	0.620	2.751	0.281	3.032
1916-17	2.529	0.586	3.115	0.313	3.428
1917-18	2.188	0.716	2.904	0.256	3.160
1918-19	2.885	0.334	2.219	0.198	2.417
1919-20	2.308	0.588	2.892	0.259	3.155
1920-21	2.221	0.305	2.526	0.237	2.763
1921-22	2.096	0.587	2.683	0.256	2.939
1922-23	2.275	0.656	2.931	0.294	3.225
1923-24	2.253	0.519	2.772	0.288	3.060
1924-25	2.385	0.635	3.020	0.292	3.312
1925-26	2.316	0.399	2.715	0.283	2.998
1926-27	2.302	0.587	2.880	0.268	3.157
1927-28	2.316	0.402	2.718	0.255	2.973
1928-29	2.395	0.507	2.902	0.269	3.171
1929-30	2.560	0.529	3.089	0.273	3.362
1930-31	2.367	0.618	2.985	0.262	3.247
1931-32	2.206	0.596	2.802	0.258	3.060

HISTORY OF SUKKUR AND OTHER BARRAGES IN SINDH
1855 TO TO – DATE
SUKKUR BARRAGE

History.

- **In 1855-57**

J.G., Fife R.E. then "Superintendent of the Nara Survey" wrote report, "A Sketch of Irrigation in Sindh with Proposal for its Improvement". To this report he suggested construction of five new canals, three of which were irrigate almost the same area as the present Sukkur Barrage, and two more, one each to irrigate left and right banks of the Indus between Jherruck and the sea.

- **In 1858**

Fife then Chief Engineer, proposed a perennial canal on the left bank of Indus to discharge 1426 cusecs in the Northern Hyderabad District (present Naushero and Nawabshah Districts).

- **In 1867**

The Government of Bombay accepted the above scheme and informed Fife (then Col. And Chief Engineer), to revise the proposal and Capt. Le Measurier R.E., was put incharge of the revision.

- **In 1867**

Captain Le Mesurier revised the above project for a perennial canal on the left Bank to irrigate 815,544 acres. The Bombay Government returned the project asking for the clear understanding with the ruler of Khairpur State, through which the canal was to pass.

- **In 1869**

After negotiations with Mir Ali Murad ruler of Khairpur State, a revised project for a canal of 7045 cusecs at a cost of Rs. 20 millions was sent to the Bombay Government, who passed it on to the Government of India and the Secretary of State for India. In 1871 the Government of India encouraged perennial irrigation in Sindh and even suggested the "Sindh Triple Project", a predecessor of Guddu, Sukkur and Kotri Barrages.

- **In November 1872**

Lord Northbrook the Viceroy of India visited Sindh, and from the information laid down before him, he ordered the project to be abandoned.

- **In 1877 and again in 1880,**

the Secretary of State for India (Lord Salisbury), drew the attention of the Government of Bombay, to the un-satisfactory state of irrigation in Sindh and asked for investigation, in Consultation with the Government of India. However the latter, after Northbrook's minute, became cold towards any extensive irrigation works in Sindh.

The improvement in the indigenous canal irrigation in Sindh was limited to straightening widening, deeping and increasing the length of Kalhora-Talpur period canals and also limited improvement of the gradients was done up to 1874, as the appendix I to XII, the lists of early British canals in Sindh show. Only three new canals Ford Briggs and Jacob wash were added since 1843. the Sindh Engineers now had only one long term alternative to improve existing canals by giving them new heads in the Riverine Areas and by merging and making many small canals as branches of larger canals. The process was to continue up to 1931. The irrigation maps of 1876, 1901, 1910 and 1931 show these major changes for canal improvement. The canals thus became government onward, rather than privately owned, operated and maintained. The Sindh canals remained mostly non-perennial, supplying water for about 90-100 days in the majority of cases and in some suitable areas for 120 days. The damage was incalculable. In other parts of the Sub-continent, specially U.P. and the Punjab perennial irrigation lead to development of horticulture i.e., evergreen and deciduous fruits, nut and industrial crops, winter vegetable and floriculture, where as Sindh's soil produced mostly only rice and a second crop in some suitable areas on preserved mixture. This in turn was limited mostly to peas and oil seeds and occasionally to horse beans and wheat. The low level of this development caused poverty, child labour, lack of government-revenue spent on schools, health facilities, high death rate and low I.Q.

- **In 1890**

Lord Reay, the Government of Bombay challenged the wisdom of carrying out inundation irrigation in Sindh, specially as it was being carried out at enormous cost in labour for lifting water on the field and ordered appointment of a committee to enquire into improvement of canal irrigation in Sindh. R.B. Joyner C.I.E, then executive engineer Hyderabad was to enquire into the practicability of a Rohri-Hyderabad canal.

- **In 1890**

Fife (then a generally), wrote a letter to the Secretary Government of Bombay, pressing for his 1855 proposal for perennial canals in Sindh.

- **In 1891**

Surprisingly Charles B. Prichard, once commissioner in Sindh after whom the Prichard (link) Canal, was built to supply water to Southern reaches of Nara Canal, now a member of Government Council Bombay, as head of the Commission appointed by Lord Reay, also became party to the refection of Joyner's report, as financially un-sound.

Tand Phuleli Zamindars and Jagirdars Association, which had already written many Memorandums to counter act Viceroy Northbrook's directives of 1872 also protested against Prichard committee's findings.

This fate of Rohri-Hyderabad canal left only one choice to Sindh, i.e. Improvement of inundation canals, these improvements between 1891-1904 are statically discussed in the last chapter and shown in canal maps of 1901and 1910.

Sincere to his 1855 project, General Fife wrote to the Secretary of state in 1893, pressing for the project and need for a separate Chief engineer for irrigation in Sindh, to advice the Government as well as, consult the Superintending Engineers (to be added) for a systematic management for a regular policy.

- **In March 1894**

Mr. Thompson then the Superintending Engineer in Sindh, rejected Fife's opinion and thus creating further problems for improvement of irrigation in Sindh.

- **In 1903**

Indian Irrigation Commission which referred to Sindh Triple Project stating that the vast scheme of this type appears to be feasible, but there are practical consideration, which would perhaps render it desirable, to reduce its scope. Sindh was represented by Chief Secretary of Bombay, Mr. John P. Muir-Machenizie Mr. Machenizie brilliantly pressed for the weir on the Indus and his performance lead to his appointment as commissioner in Sindh in 1904.

The Indus Irrigation Commission set up by Lord Curzon in 1901-1903, took two important decisions. Diversion from the river Indus was not allowed without assent of Sindh. The Commission also laid down the policy that irrigation projects concerning more than one province had to be too referred to the Governor General of India, for his decision.

- **In 1904**

Dr. Summers Superintending Engineer in Sindh sought permission of Government to take a canal from Rohri across the Khairpur State, to feed Dad

canal and pointed out; "Continuous increases of irrigation in the Punjab will eventually force a weir upon us".

- **In 1905**

Dr. Summers obtained permission to extend his survey of canal beyond Dad canal, across the Central Hyderabad canals, to the lift lands of Phuleli canal and end in Dhoro Puran below Jamrao tract.

- **In 1906**

J. Benton, Inspector General of Irrigation Government of India, visited Sindh, to enquire in to possibility of perennial canal in Sindh and suggested what investigations should be made for a weir and canals with an off-take at Rohri.

In the same year (1906), the Government of India, suggested to the Government Bombay, that increasing cold weather with-drawls in t he Punjab, would diminish supplies in the inundation canals in Sindh and suggested that eventually, requirement of canal waters in Sindh, can be met from:

- Mithan Kot.
- Sukkur or Sehwan.
- Kotri or Jherruk.
- Sehwan.

For the present only second system, need to be considered. The fore-sight in this suggestion was a weir at Sehwan, un-determined by Fife and his successors and not again discussed seriously until KIP report of 1965 pressed for its execution.

1903 – 1920 were the years of great development in construction and earth moving machinery. In 1903 ford had already developed Model-T car, which remained unbeaten for 25 years. Caterpillar had developed crawler tractors, Le- Tournea developed scaper, and bulldozer blade and power winch, to operate them. Rustons of England developed stationary and portable diesel engines and in addition jointly with Bucyrus developed drag-lines, clam-shells, cranes, drilling and blasting rigs and pile hammers. Multi-cylinder petrol engines were already operating compressors and multi cylinder diesel engines too were developed. For higher power requirements multi-cylinder light steam engines with portable boilers became available. These new tools not only lowered the construction costs, but cut down on labour for earth moving, which was difficult to get in Sindh and the donkey labour would have taken many years to accomplish task of excavation of the canals and constructing the weir (barrage) at Sukkur/Rohri.

Working on triple canal project in January 1910, Dr. Summers showed that the Triple Canal Project would give a return of 4.25% exclusive of interest on capital outlay during construction and was un-remunerative but was convinced that it could be made more remunerative by construction Rohri Canal first, (which will remain inundation canal) until weir is constructed . This way, there will be saving of 1.5 to 2.0 millions per annum on the interest.

In summer 1910 he sent a revised proposal, at the following estimates:

-	Rohri Canal	Rs. 4,412, 861
-	Barrage or weir	Rs. 30,000.00
-	Widening Nara	Rs. 4,000.00
	Total:	**Rs.78, 812,861**

The attitude of Thompson and summers, not expand the irrigation administrative organisation vertically and horizontally, beyond the level of one Superintending Engineer for the whole Sindh, was responsible for maximum harm to Sindh.

- **In 1913**

The British had difficulty at home in getting raw cotton for their own textile industry. Japan and USA had developed their own textile industries and the British were faced with difficulty of getting raw cotton. The British now felt that vast un-cultivated areas in Sindh could be profitably utilised for raising cotton as dry climate of Sindh combined with adequate heat days was most suitable area in the Sub-continent for raising cotton. Hence for the quick decision for executing Sukkur Barrage were motivated by the British interests.

The British related the development in Sindh, primarily was to connect Karachi with a Delhi and Lahore to take surplus grains from the Punjab abroad, easily, economically, and imperiously and this policy of no further urgency to develop irrigation in Sindh, changed over night due to demand for cotton in England.

Lack of development of irrigation in Sindh, resulted in lack of agriculture surplus and therefore under development of urban centres in Sindh. In 1984-85 there were only six towns in Sindh having population of more than 10,000 persons but none above 100,000. It was only 1901 that Karachi had a population of 120, 000 but still there were only six towns having more than 10,000 populations.

- **In 1912-13,**

Secretary of State for India appointed a Committee to examine, Dr. Summers report. The report came out in December 1913, which stated that:

1. Project was not a protective measure but was not productive either, as the period of execution was very long (up to 16 years).

2. It was pre-mature.

3. The scheme should be prepared and kept in readiness, as Sindh may suffer due to more with drawls of water in the Punjab in future.

4. Site for Barrage on up stream side of Rohri did not appear to be suitable.

5. In 1915 Mr. A.A. Msto was put on special duty under Chief Engineer in Sindh, to revise the project, named as Sukkur Barrage Project.

6. In 1917, Inspector General of Irrigation, Sir Thomas Ward visited Sukkur and a conference was held at Sukkur, with the Chief Engineer Sindh and the Chief Engineer Bombay. Subsequently meeting was held with the Commissioner in Sindh at Karachi. The Inspector General guided by his predecessor Maechel Nethersole's minute, made the following important suggestions:

7. Involvement of Revenue (Revenue and Survey and Settlement) Department as well as Canal officers (Executive Engineers).

8. Ship's lock may be dropped (This was a mistake as time has proved).

9. Canals may be kept small for economic use of water.

10. Remodeling inundation canals to fit in new canals of Barrage by methods as adopted in t eh Punjab.

11. Rohri canal should not be constructed as inundation canal first and then merged in Sukkur Barrage system, as remodeling after the Barrage may be costly.

12. Discharge of Rohri canal should be reduced from 15,500 to 10,000 cusecs (It was designed for 9,500 cusecs and today it carries 16,000 cusecs).

13. Revenue, Agriculture and Irrigation Officers should work out a payable scheme and demonstration farms may be established.

Plans and estimates fro barrage and canals prepared in 1919 and 1920 respectively, were sent by Government of Bombay to Government of India and passed on to Secretary of State for India, who gave the approval in April 1923

and construction started on July 1923. The Barrage was completed in December 1931 and opening ceremony performed by Earl of Willington, Viceroy and Governor General of India on January 13, 1932.

The Government documents in general are silent about the role of public opinion and protests on the question of Sukkur Barrage. Role of Tando Phuleli Zamindar and Jagirdars has already been mentioned since 1872. But role of another two workers, Ghullam Muhammad Bhurgari and Seth Harchandrai is commendable. The former pursued the Sukkur barrage Project in Sindh Provincial Conference year after year and accompained by the latter, met with Edwin Montage Secretary of State for India in 1918, to pursue the project, which could any time be dropped for want of funds. As result of persuasion by Ghullam Muhammad Bhurgari, Harchandrai and Lawrence the Commissioner in Sindh, E.M. Montagu, Secretary of State sanctioned the project and in ensuring 18 months, settled the question of funding the project by loan from Government of India. He gave final approval to the project in April 1923.

Construction of Barrage started on 1st July 1923.

In 1923 District Local Board Larkana, under the influence of Sir Shah Nawaz Bhutto, unanimously passed a resolution that the Sukkur Barrage may be named as the Lloyd Barrage after George Lloyd Governor of Bombay.

In July 1923, the Government of Bombay issued orders that in view of recommendation of the Larkana Local Board, Barrage may be called George Lloyd barrage (not Lloyd George Prime Minister of England), after the then Governor of Bombay.

Specialised construction techniques.

Once Sukkur Barrage Scheme was approved in 1916, the engineers had to give a thought to construction methods and techniques to take up a gigantic project, such as had never been executed in the World before. It was known that labour for construction of the Barrage would be a few hundred thousand men, for some years, which number shall not only be difficult to get, but will raise that labour rates. 1917 A.D. influenza had killed 40% rural population of the Sindh and with-drawing labour from Sindh would have adversely affected the agricultural operations. It was therefore decided to employ machines, some of which were specially designed and built for the purpose. They performed following types of operations:

- Interlocking sheet pile hammers for coffer dams and pile sheets.

- Dredgers fro depositing sand inside the steel pipes and also excavating the foundations inside cofferdams.

- Dewatering by pontoon mounted electric, centrifugal and reciprocating pumps, as well as well points.

- Forty two miles of railway lines at the Barrage-head construction site, along with locomotives and truck (wagon) mounted cranes.

- Pontoon mounted cranes.

- Electric supply from an independent power house for the construction.

- Forty six excavators of various sizes, for excavating canals. These worked round the clock, for 5 ½ days a week and 250 days a year, excavating about 10.4million cubic feet per day equivalent to 32,000 men working all the year around or 77,000 men for 5 months of the working season (winter months only).

- Workshop for maintaining and servicing the machine.

- The machines were able to excavate about 5.7 billion cubic feet earth for canals at rates much lower than labour rates prevailing then.

The cost of machinery employed including operating costs, formed about 22.6% of overall cost of the Barrage.

Four other major technological improvements were also introduced along with sanctioning the Sukkur Barrage project. These were:

Rectangulation of Land

The Survey of India, rectangulated farming land down to 320 acre rectangles. The Revenue officer Sukkur Barrage, further rectangulated land, down to the one acre plot. Standard size of an acre was fixed as; north to south 264 feet and east to west 165 feet. This made it easy to level land and gave better control of water into each plot. The water courses could there-after is laid economically along the borders of plots. A further benefit to the farmer was assessment of land and water rates, to one acre, instead of larger plots. Rectangulation helped in orientation of orchards in the most advantageous solar light direction of north to south.

Soil Survey

Government surveyed the soils and classified them as classes A, B, C and D; denoting good, fairly good and poor quality land fit for rice, only after washing. D class was unfit for cultivation except at high reclamation cost. Facilities of water for reclamation were provided for class land.

Agricultural Research

Agriculture Research Station was established at Sakrand in 1924 A.D., for research into new crops and cropping patterns. This finally lead to establishment of Agricultural College (then known and King George-V College) at Sakrand , a predecessor of the Sindh Agricultural University Tando Jam. The already existing Fruit Farm at Mirpurkhas was strengthened to encourage perennial fruit crops; like mango, citrus, guava, banana, dates, winter vegetables, and etc. Rice Research Station was established at Dokri. A number of small research stations were established near Thatta, Dadu, Larkana, Shikarpur and etc.

Water Logging and Salinity measurements

More than 3000 piezometers were installed in the irrigated areas to monitor water table.

Prosperity brought by the Sukkur and other barrages.

The Sukkur Barrage brought prosperity to Sindh by assured summer and winter water. The situation before the barrage is best described by Fife in 1859. He stated that during first inundation season he was in Sindh, there was too little water, during the second there had been too much, during the third inundation had risen too late in the season and during the forth it had subsided too early; during the fifth there was too much water. Thus he analysed that there was always some thing wrong; there was always too much or too little water or river rose too late or fell too early.

The prosperity that Sukkur and other Barrages provided could be seen from 6 fold increase in population over 50 years, and 350% increase in cultivated area, with 7 universities, 6 medical colleges and etc. the agricultural surplus produced has increased urban population to more than 35% of whole population.

SALIENT FEATURES OF SUKKUR BARRAGE

1,	Total latest revised estimated cost of the whole scheme (1935).	£ 15,000,000.00 Rs. 2,003,300,000.00
2.	Total estimated cost of Barrage and Head Works.	£ 4,300,000.00 Rs. 55,897,000.00
3.	Total length of canals of all size excavated	6,473 miles
4.	Total quantity of earthwork to be excavated in the scheme for canals, branches, distributaries and minors.	5,690 million cu. Ft.
5.	Total length of new and old watercourses 30,000 + 17,800 miles.	47, 800 miles
6.	Total cost of 46 dragline machines employed for excavation work.	£ 800,000.00 Rs. 10,666,000.00
7.	Total cost of all machinery employed inclusive of draglines.	£ 400,000.00 Rs. 45,333,000.00
8.	Total quantity of earth works canals + watercourses 6,280 + 1, 240m cu. Ft.	7, 520 million cu. ft.
9.	Total number of bridges and regulators to be constructed	1,970
10.	Maximum labour employed any time	60,000 persons.
11.	Grass area commanded by the Scheme (in British Territory.	7.4 million acres.
12.	Annual cultivation when area is fully developed (in British Territory).	5.01 million acres.
13.	New area of virgin soil brought under command.	1.95 million acres.
14.	The Barrage across the River Indus had 66 spans of 60′ each with 2 extra land spans to the "gate" bridge Chill level of Barrage Full Supply Level R. L of springing of gate bridge arches. The "gate" bridge is for manipulating the gates in the openings of the Barrage, and the "road" bridge is for traffic.	 R.L. 177.0. R.L. 195.5. R.L. 219.0. R .L. 201.0.
15.	Work commenced in July 1923. (a) All work expected to be finally completed and Accounts closed in 1934-35. (b) Canals to flow in 1932.	
16.	Government land that would come under	

	command: A Class Land B Class Land C Class Land	1,058,928 acres. 602,205 acres 289, 400 acres
17.	Gross Command Area. A Class denotes good quality land. B Class denotes fairly goof quality land. C Class denotes poor land fit for rice and then only after washing.	8.3 million acres 7.8 million acres.

ACTUAL CANAL DISCHARGE AS COMPARED WITH DESIGNED CAPACITY OF 7 CANALS OF SUKKUR BARRAGE

NAME OF CANALS	DESIGNED CAPACITY	ACTUAL DISCHARGE AT PEAK DEMAND
North Western	5,042	9,500
Rice	10,215	13,770
Dadu	2,837	5,738
Nara	13,602	14,452
Rohri	10,887	16,385
Khairpur East	2,094	2,648
Khairpur West	1,940	3,440

TABLE SHOWING THE YEAR WISE CULTIVATION FIGURES ON SUKKUR BARRAGE SINCE ITS INCEPTION, TO OPENING OF OTHER BARRAGES

Year	Cultivation in Millions	Year	Cultivation in Millions
1932-33	2.428	1956-57	4.744
1933-34	2.783	1957-58	4.797
1934-35	2.728	1958-59	5.182
1935-36	2.887	1959-60	5.271
1936-37	2.985	1960-61	5.264
1937-38	3.208	1961-62	5.460
138-39	3.206	1962-63	5.627
1939-40	3.365	1963-64	5.741
1940-41	3.485	1964-65	5.644
1941-42	3.425	1965-66	6.000
1942-43	3.224	1966-67	6.052
1943-44	3.413	1967-68	6.251
1944-45	3.282	1968-69	6.368
1945-46	3.523	1969-70	6.351
1946-47	3.684	1970-71	6.249
1947-48	4.093	1971-72	5.838
1948-49	3.859	1972-73	6.021
1949-50	3.936	1973-74	6.214
1950-51	4.130	1974-75	6.219
1951-52	4.361	1975-76	6.395
1952-53	4.541	1976-77	6.572
1953-54	4.650	1977-78	6.675
1954-55	4.762	1978-79	7.041
1955-56	4.866	1979-80	7.285

KOTRI BARRAGE PROJECT 1955

As mentioned earlier the supply in Sindh Inundation Canals in Upper and Lower Sindh went on decreasing and the need for building two Barrages was more than established. The Government of Sindh opened a Project Circle under able guidance or Mr. Champekar a Superintending Engineer who in August, 1946 submitted the two projects namely Guddu Barrage and Canals Project and Kotri Barrage Canals Project. The Lower Sindh inundation canals being situated at the tail end of Indus Basin were given the priority and Government of Sindh accorded administrative approval to Kotri Barrage Project in September, 1946. Two sites for the location of the barrage were considered one at Jherruk and the other at Jaijipur, but latter was finally adopted in the project. The Barrage proposed in the project was a double Barrage with an island 200 ft. wide in between. The proposal was based on the model experiments carried out at Poona on the best alternative for silt exclusion from canals.

However the following changes were ultimately made at the suggestion of Sir. T.A.W. Foy who headed it as Chief Engineer / Secretary Irrigation.

i. Single Barrage instead of a Double Barrage.
ii. Sitting Barrage 1500 ft. north of original line.
iii. Gravity Section floor against RCC raft floor.
iv. Sitting the Barrage on the right bank of river with right abutment practically at the existing edge of the river.
v. Ring Bund method of construction against coffer dam method.

There are four feeders which originate from this Barrage and their details are as under:

Name of Feeders	**Design Discharge**	**Length**	**B.W.**	**Area commanded**
Lined Channel (Akramwah)	3,713 cusecs.	76.2	Miles	487,347
New Phuleli.	15,026 cusecs	59.8	Miles	929,358
Old Phuleli	13,636 cusecs	56.48	Miles	786,353
K. B. Feeder	100 cusecs	58.38	Miles	637,041

The salient features of Kotri Barrage Project

(1) An entirely new canal called Akramwah with its head portion 38 miles lined.

(2) Conversion of Keenjhar, Sonhari and few other small lakes into one big lake now called 'Keenjhar Lake', having total storage of 0.525 MAF and live storage of 0.37 MAF.

(3) Keenjhar Lake forming an integral part of irrigation system on the right bank. K.B.P. (Upper) out falls in the lake at its northern tip at Chull and K.B.F. Lower with design discharge of 6954 cusecs off takes from Keenjhar Lake at the lower Southern end of the lake.

(4) Excavation and construction of 929.32 miles of new channels.

(5) Remodeling of 1075 miles of old channels..

(6) Providing Perennial irrigation for 839,600 CCA and non-perennial for 1,967,200 areas of CCA.

(7) Providing two MGD of water to Hyderabad Municipal Corporation for its demestica use.

(8) Providing two MGD of water to Hyderabad Municipal Corporation for its domestic use.

On the persistent demand of cultivators of right bank for supply of silt laden water, a new Link Canal 21.5 miles in length, bye-passing Keenjhar Lake and joining K.B.F. Upper with Lower has been completed during the year 1982.

(i)	Estimated cost of the Project (As per revised PC-I 1980)	Rs. 810.0 Millions
(ii)	Maximum Designed river discharge.	Rs.875Million Cusecs
(iii)	Maximum Flood Discharge (1958).	Rs. 981 Million Cusecs
(iv)	Length of the Barrage (between abutments).	2, 984 Feet.
(v)	Number of Spans.	44
(vi)	Width of Spans	60 Feet.
(vii)	Gross Area Commanded	3.39 Million Acres
(viii)	Culturable Commanded Area.	3.013 Million Acres.
(ix)	Annual cultivation achieved (1979-80)	R. 1.77 Million Acres
(x)	Length of Canals.	252 Miles.
(xi)	Number of Structures.	792 Nos.

GUDDU BARRAGE PROJECT (1962)

With substantial progress having been made on Kotri Barrage project, the Government of Sindh initiated work on Guddu Barrage project and appointed in 1953 Late Mr. A.R. Kazi, S.Q.A. a celebrated engineer of Sindh incharge of this project. The work on the Barrage construction could not start till the work on Kotri Barrage was completed and machinery and equipment rendered surplus form that project. However, the work on excavation of Begari Sindh Feeder was started with small dragline excavators and preliminary works of construction of colonies, roads, railway lines etc. started in 1953-54.

On the formation of Water and Power Development Authority (WAPDA), the project passed on the WAPDA. Guddu being the first project to WAPDA, it received priority attention of persons like M/s Ghulam Farook and Ghulam Ishaque Khan and Sial the then Chairman and Members of Authority respectively, who took all steps to give required momentum to this project and accelerated the progress of works.

The barrage was completed in 1962 and final diversion of river took place on March, 1962. The right bank feeders namely Begari Sing Feeder and Desert Pat Feeder started getting Barrage controlled supplies in May and July, 1962 respectively. The Ghotki Feeder however was connected with the head works a year later and it started to operate as Barrage Canal in June, 1963.

The salient features of the Barrage are:

(i) A dry crop canal 22 miles in length namely Kacha Kharif feeder was introduced in the project for irrigating a riverain area of 22,873 acres

(ii) A canal called Pat Feeder Canal for irrigating about 0.6 million acres of Balouchistan area was incorporated in the project.

(iii) A new feeder canal, the biggest in the province namely Begari Sindh Feeder 78.6 miles in length with 14,764 cusecs design discharge at head was introduced.

(iv) The new Pat Feeder Canal was joined with Desert Canal and a common Feeder called Desert Pat Feeder with design discharge of 13,273 cusecs as head was provided.

(v) On the left bank 37.026 acres of river an area was protected by 36 miles of river protection bunds viz, Baiji, Ranwti and Qadir Pur.

(vi) The project involved construction of 405 regulators 643 Bridges and 722 other structures of all descriptions.

(vii) New 179 canals in number and 1040 miles in length were remodeled.

Date of feeders:

Name of Feeder	Design Discharge	B.W.	Length	CCA	Cropping pattern
B.S. Feeder.	14,764	240	78.6	10.02	Rice
Desert Pat Feeder	13,275	240	7.5	5.12	Rice
Ghotki	8,490	193	79.6	8.57	Rice

SALIENT FEATURES OF GUDDU BARRAGE

(i)	Estimated Revised Cost (1980)	Rs.96.9 Million
(ii)	Maximum Design River Discharge.	Rs. 1,20 Million Cusecs
(iii)	Maximum Flood Discharge (1976)	Rs. 1.20 Million Cusecs
(iv)	Length of the Barrage.	4445 Feet.
(v)	Number of Spans.	64 Nos.
(vi)	Width of Spans.	60 Feet.
(vii)	Gross Area Commanded.	3.269 Million Acres.
(viii)	Culturable Command Area.	3.030 Million Acres.
(ix)	Design Full Supply Discharge of Canals.	36, 529 Cusecs.
(x)	Annual Cultivation achieved (1979-80).	2, 49 Million Acres
(xi)	Total length of all canals, Branches, Distributaries and Minors.	2604 Miles.

POST INDEPENDENCE DEVELOPMENT IN SUKKUR BARRAGE COMMAND (1947 TO DATE)

A large area measuring about 50,000 acres was under Makhi Forest. With the pressure of population and government campaign for grow more food, it was decided to deforest this area and colonies it under military Families Rehabilitation scheme. Accordingly, a new channel, namely Samatri was constructed and two old ones namely Hearn and Beghded were extended and remodeled in 1945 and area colonized.

As an extension of this scheme, two more channels were excavated from Jemrao canal in mid sixties. These were Sadrat-I and Sadrat-II with minors called feeders Ex-Sadrat - I and Sadrat – II and with discharge of 188 cusecs were excavated for irrigation 56,000 acres of land. The total CCA OF Makhi area brought under irrigation was 1.28 Lac areas.

	CCA	**D.D.**
Samatri.	22, 192 Acres	68.57 Cusecs
Sadrat-I.	7, 274 Acres	24.89 Cusecs
Sadrat-II	28, 899 Acres	92.6 Cusecs
Feeder Ex-Sadrat-II	9, 444 Acres	27.4 Cusecs
Feeder Ex-Sadrat-I	10, 595 Acres	33.34 Cusecs
	78, 424 Acres	**256.80 Cusecs**

Also in late fifties, yet another scheme of colonisation for retired Army personnel was launched in Nawabshah District and an area of 4,000 acres was provided with irrigation supplied by a new canal called Setharki Distributory with design discharge of 15 cusecs at head and 14 miles length. This has been extended during 1979-80 by 4 miles to provide better irrigation facilities to the area at tail.

As per Sukkur Barrage Project an area of 23,000 acres in Rohri and Nara Taluka of Khairpur was planned to receive lift irrigation from Nara canal. In the absence of electric power, only a fraction of this area could be brought under cultivation in private section by diesel driven lift pumps. The Government of Sindh therefore launched in year 1954-55 a project of constructing seven channels, three on the right and four on the left bank of Nara canal. These channels, three on the right and four on the left bank of Nara canal. These channels with CCA of 22,769 acres and total length of 30 miles we constructed /completed in year 1955. Three more projects of lift channels were also launched in year 1967-68, 1972-73, 1979-80 and 1981-82. Under these projects further area

of 67,710 acres was brought under irrigation by constructing 13 channels of total length of 40 miles and an aggregate discharge of 188 cusecs.

On the right bank of river Indus between Sehwan and Jamshoro lies the Khirthar range of hills with ground sloping from foot of hills in this narrow belt of 90 miles in length. The irrigation net work of right bank canals of Sukkur Barrage System terminate at Sehwan and these fertile areas had no source of reliable irrigation. It was however prone to receive spill irrigation from Indus when in floods and from Khirthar hills streams during period of high precipitation.

The Government of Sindh therefore in year 1955-56 launched a project called Shah Awasi Pumping Scheme with headworks at Sann town. Three pumps of 44 cusecs capacity were mounted on barges which provided much needed irrigation supplies 83 cusecs during Kharif season, for irrigating settled area of 19,392 acres. The total length of canal systems of this scheme is type of four more pumping schemes have been commissioned on the right bank.

Danistar Canal 1972.

The tail command of Dadu Canal had been the victim of serious shortage of water, the main causes being (i) the change in cropping pattern specially in upper reach of Dadu Canal from dry to rice and (ii) too inadequate water allowance of 2.7 cusecs per 1,000 acres which in the arid climate as that of Sindh provided Kharif intensity of 22% Rabi.

The Government of Sindh appreciating the demand of cultivators of Sehwan – Bubak area, ordered the revival of Danistar Canal which was an old inundation canal Ex-Manchar but was closed during Sukkur Barrage project. A canal 12 miles in length between River Flood Protective Bund and Manchar Containing Bund with regulators at both ends and bed width of 50 ft at uniform level was excavated in the abandoned bed of Dasister canal.

The benefit of Danister has been increased by excavating Phito-Wah Ex-Danister. The entire system provides lift irrigation only. The canal during summer flows from river to Manchar and helps in supplemental filling of Manchar Lake also and in winter it draws water from Manchar.

Matli Branch 1078-79.

Lake Dadu Canal certain tail of Rohri Canal system especially in Hyderabad Matli Zone experienced serious shortage of irrigation supplies. These areas which once flourished with bumper crops in both the seasons turned barren. In order to improve the lot of the farmers of this area, the government sanctioned Matli Project which comprised of a canal Ex-Fuleli and after

siphoning Akramwah supplies to the area settled on the tail reaches of Baran, Khachar, Soomrak, Chakar, Tando Ghulam Ali, Bhuhro etc.

Similarly tow lift channels ex-Fuleli carrying supplies across Akramwah by aqueducts have been constructed for the tail areas of Mohammad Khan Distributory and Seri Fazal Minor.

A new channel called Shah Latif Minor 4.3 miles in length with 20 cusecs discharge at the head was constructed and inaugurated on 09.11.1980.

The total canal command area in Sindh is 13.2 million acres out of which 7.8 millions (Approximate 60%) acres is settled on Sukkur Barrage canals system. The area receiving perennial irrigation is 7.3 cusecs of 1,000 acres which in practice suffices for Kharif intensity of 22% and Rabi intensity of 43% approx. in the present day socio-economic conditions, and specially in absence of fresh ground water such a low intensity of cultivation is too inadequate to meet the needs of farmers who by and large have to depend solely on surface water. The Project for preparing feasibility report and project design are therefore in hand. Those pertaining to remodeling of lower reach of Nara Canal and Rohri Canal system have already been completed and that for remodeling North Western Canal is shortly to be completed awaiting the financial allocations.