Report - Sukkar Barrage Canals Project 1919-20 Vol. XX (1920)

Messrs. Baker & Lane

SUKKUR BARRAGE CANALS PROJECT
1919-20.

VOLUME XX.

REPORT

BY

Messrs. BAKER & LANE, 1919

AND

Orders of Bombay Government thereon

1920.

BOMBAY
THE TIMES PRESS
1923.

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GOVERNMENT OF BOMBAY

PUBLIC WORKS DEPARTMENT

Resolution No. W.I.—11055

Bombay Castle, 20th August 1919.

Letter from Messrs. C. M. Baker and C. M. Lane, Collector and Executive Engineer on special duty, respectively, dated 15th March 1919—Submit through the Commissioner in Sind their report* on the Indus Barrage projects.

Memorandum from Commissioner in Sind No. Rev.—997, dated 17th April 1919, as under :—

"The Commissioner in Sind has the honour to forward the report* on the Indus Barrage project submitted by Messrs. C. M. Baker, I.C.S., and C. M. Lane, Public Works Department; and desires to draw the attention of Government to the thoughtful care with which every detail of the important problems involved has been investigated and to the admirable lucidity with which the conclusions arrived at have been set forth. The Commissioner is aware that these conclusions are based upon most conscientious observation in the field and very elaborate calculation in the office.

"2. At intervals during the preparation of this report, the Commissioner summoned conferences of various officers concerned for the settlement of the points for enquiry and for discussion at early stages of the various theories and suggestions which are involved in an enterprise of this colossal magnitude. The conferences were held on the dates under-stated and attended by the officers noted :—

Conference of January 19th, 1918, attended by	Conference of January 20th, 1918, attended by	Conference of November 30th, 1918, attended by	Conference of February 3rd, 1919, attended by
1. The Honourable Mr. H. S. Lawrence, C.S.I., I.C.S., Commissioner in Sind.	The Honourable Mr. H. S. Lawrence, C.S.I., I.C.S., Commissioner in Sind.	The Honourable Mr. H. S. Lawrence, C.S.I., I.C.S., Commissioner in Sind.	The Honourable Mr. H. S. Lawrence, C.S.I., I.C.S., Commissioner in Sind.
2. Mr. T. R. J. Ward, C.I.E., M.V.O., M.I.C.E., Inspector General of Irrigation in India.	Mr. G. S. Henderson, Imperial Agriculturist.	Mr. T. R. J. Ward, C.I.E., M.V.O., M.I.C.E., Inspector General of Irrigation in India.	Mr. F. St. J. Gebbie, Secretary to the Government of Bombay, Public Works Department.
3. Mr. F. St. J. Gebbie, Chief Engineer and Secretary to the Government of Bombay, Public Works Department.	Mr. W. Roberts, Principal and Professor of Agriculture, Lyallpur.	Mr. F. St. J. Gebbie, Secretary to the Government of Bombay, Public Works Department.	Mr. F. Wright, Chief Engineer in Sind, Public Works Department.
4. Mr. F. Wright, Chief Engineer in Sind, Public Works Department.	....	Mr. F. Wright, Chief Engineer in Sind, Public Works Department.	Mr. C. M. Baker, I.C.S., Collector on Special Duty.
5. Mr. C. M. Baker, I.C.S., Collector on Special Duty.	....	Mr. C. M. Baker, I.C.S., Collector on Special Duty.	Mr. C. M. Lane, Executive Engineer on Special Duty.
6. Mr. G. S. Henderson, Imperial Agriculturist.	....	Mr. G. S. Henderson, Agricultural Controller.	Mr. A. A. Musto, Executive Engineer, Sukkur Barrage.
7. Mr. W. Roberts, Principal and Professor of Agriculture, Lyallpur.	....	Mr. C. M. Lane, Executive Engineer on Special Duty.	Mr. T. F. Main, Deputy Director of Agriculture, Sind.
8. Mr. C. M. Lane, Executive Engineer on Special Duty.	....	Mr. A. A. Musto, Executive Engineer, Sukkur Barrage.	Mr. V. A. Tamhane, Agricultural Chemist.

Copies of the minutes* of these conferences are attached as some proof that the questions involved have been considered from many different points of view by officers of varied experience who possess some claim to speak with authority.

"3. The Commissioner ventures to review briefly for the information of Government the agricultural economy of Sind as it exists now and as it will be modified when the Sukkur Barrage project is completed. On an average of seasons in round figures the province has an annual cultivation of 4,000,000 acres, of which 400,000 or 10 per cent. are dependent on rainfall, and 3,600,000 or 90 per cent. are dependent on irrigation from the river Indus. This project may be considered in three parts : the Right Bank Canal, the Left Bank Canal, and the far eastern canals known as the Eastern Nara system. In this last named system no change of the canals is proposed ; the only effect of the barrage will be to give an assured supply to the existing canals. This improvement of the supply will, it is calculated, enable a further 200,000 acres to be brought under cultivation.

*Printed separately.

"4. In the area, however, commanded by the right bank and left bank canals, the existing canals will be superseded and abandoned; and very large areas will be brought under command of flow water which never had any water before or which only had water raised by mechanical appliances. In these latter areas the extension of annual cultivation would be from 1,000,000 to 1,600,000 on the right bank, and from 700,000 to 2,100,000 on the left bank.

"5. Beyond the scope of the Sukkur barrage there will remain in Sind 700,000 acres of annual cultivation to the north which lie too high to receive this water; and 600,000 acres to the south which are situated too far away to be reached by these canals.

"6. To recapitulate: Out of 3,600,000 acres, the annual irrigational cultivation, this scheme does not touch 700,000 to the north and 600,000 to the south; and on the remaining 2,300,000 it will provide an increase of 2,200,000 of annual cultivation, thus doubling the cultivation of the whole of the central area of Sind.

"7. The increase of area, however, represents only a fraction of the advantages to be derived from the introduction of this system. Water will be under complete control; and the losses due to the vicissitudes of supply, to the sudden floods, and to the prolonged droughts will cease. Perennial water will further provide agricultural employment all the year round in lieu of the prolonged periods of enforced idleness now prevailing. It will also enable the establishment of a dairy industry to which the province with its famous breed of cattle is admirably suited.

"8. The increased land revenue earned by the triple project will rise through decennial stages of Rs. 83,00,000 and Rs. 1,23,00,000 to Rs. 1,72,00,000 in the 30th year. The present average land revenue of Sind is Rs. 110 lakhs, and these figures indicate that the existing revenue of the whole province will be almost trebled within 30 years of the completion of the project.

"9. Detailed estimates of the cost of the project are not as yet available; but it should be in the neighbourhood of 14 crores of rupees. It is calculated that the whole scheme will earn on this vast sum an interest of 6 per cent. in the first 10 years, of 8½ per cent. in the second 10 years and of 12 per cent. in the third 10 years and thereafter.

"10. The Commissioner has the honour to express his complete acceptance of these estimates and his confident belief that this project may be carried through to completion with full assurance that it will effect a most beneficent revolution in the prosperity of the province; and will prove to be one of the most remunerative irrigational successes of Government."

RESOLUTION.—Government concur in the remarks made by the Commissioner in Sind in paragraph 10 of his memorandum and are pleased to direct that the proposals made by Messrs. Baker and Lane should be accepted as a basis for the remodelling of the Left Bank Canal and the preparation of plans and estimates for the Right Bank Canal.

2. Government generally agree with the remarks made by Messrs. Baker and Lane in paragraph 56 of their Report on the Right Bank Canal regarding the proposal to irrigate a part of the Nasirabad Tehsil by a canal from the barrage. Mr. Musto, Executive Engineer, has submitted certain reports on this point and orders thereon will issue separately.

V. F. BARKER,
Acting Under Secretary to Government,
Irrigation and Railways.

G. R. No. W. I.—11055, P. W. D., dated 20th August 1919.

To

*The Revenue Department, Secretariat.
*The Commissioner in Sind.
*The Chief Engineer in Sind.
*All the Collectors in Sind including the Deputy Commissioner, Upper Sind Frontier.
*The Director of Agriculture.
*The Superintending Engineer, Indus Left Bank Division.
*The Superintending Engineer, Indus Right Bank Division.
*The Accountant-General, Bombay.
*C. M. Baker, Esq., I.C.S.
*C. M. Lane, Esq.
*All Executive Engineers in Sind.

*With copy of the Report.

Class A.
Exd. J. P. R.

No. of 1919.

Copy forwarded for information and guidance to

No. S.—217 of 1919.

Office of the Chief Engineer in Sind.

Karachi, dated 8th April 1919.

From—F. WRIGHT, Esq., Chief Engineer in Sind ;

To—The Commissioner in Sind.

Sir,

I have the honour to say that I have read with care and much interest the excellent report on the Indus Barrage Projects prepared by Messrs. C. M. Baker and C. M. Lane. I am well acquainted with the controversy which led to the appointment of the Committee now reporting, and I can say, with confidence, that at length one can fairly feel no longer is there reason for many of the doubts which would arise in the mind of any Sind Officer of experience who had read some of the literature previously issued in connection with the barrage canals and the country to be served by them.

2. The Committee reports in chapter I that the cultivable areas both in the Left and Right Bank spheres of barrage water influence are in marked excess of what previous estimates adumbrated. That was a thing which I anticipated would be ascertained by a soil survey such as has now been conducted. And, further, I anticipated that this survey would be of the greatest possible value when it shall come ultimately to the aligning of water courses.

3. Chapter II of the Report deals with the selection of suitable duties in various canal situations. This is a matter which has already had careful consideration at several canal conferences within the last few years, and with the arguments advanced in favour of the figures chosen I have nothing to say beyond that in my opinion the Committee are very fair in their selection and that I expect time will prove that duties now common in the Punjab will be attained to after the Sindhi cultivator has accustomed himself to the enormous change this thing of established perennial water-supply means.

4. In paragraph 5 *et seq*, of chapter III of the Report the matter of the suitability of the Left Bank country for cotton cultivation is referred to. Messrs. Baker and Lane have explained quite clearly why it is impracticable, undesirable, and uneconomical that that country have provided for it canals other than those they stipulate for. I wish it to be understood that I am in full accord with the opinions of those gentlemen. At the same time I would point out that it is likely to be very important to extend to the utmost cotton cultivation in Sind in particular, and over and above the great area which it is provided the Left Bank canal can raise, it is not unlikely that in the Right Bank country, in definite areas, people who now would grow rice will hereafter take to cotton when they see what prosperity it is bringing to their friends on the other side of the river. Already there have been instances of the rice cultivator abandoning that crop in favour of cotton, and this may become a desirable feature of agricultural enterprise in the southern canal area on the right bank.

5. Without a more extensive knowledge of the facts I am not prepared to endorse what the Report says in paragraph 13 of chapter IV with respect to the perennial branch canal suggested for the irrigation of villages in Jacobabad and Nasirabad. Setting aside political aspects of the case, about which I am not in a position to offer any remarks; it seems to me quite clear that when perennial water can be brought to a place which otherwise would have no water at all, or else the fickle supply that an inundation canal can give, then the arguments in favour of any thing other than a perennial supply will be found unsound.

6. I have always been and am still very optimistic respecting the supply of the Indus in the cold weather. I have no fears of deficiencies in the rabi watering canals on that account. In this spring, after the remarkably feeble monsoon of 1918, the supply in the river at Sukkur has not been below 23,000 cusecs and that at a time when the Punjab canals were taking all the water they wanted. The coming of the Sind Sagar canal is no bug-bear to me.

7. Chapter V deals within the Eastern Nara. The Committee see no object in pressing for an extension of the irrigated area in this locality at an early date. With that view I concur. At the same time it must not be overlooked that in the Nara Valley between the Mithrao protective embankment and the Nara itself there is in the bay north of Kipro a very large area now without a water-supply, and also west of the Nara itself and for many miles south of Samara to the Rann there is a strip of country of considerable magnitude which can be brought under cultivation when canals and people are available for the purpose.

8. The irrigation of forests is touched upon in chapter VI. What I would like to see become an accepted policy of forest cultivation in Sind is the extension of areas under forest in many of the favourable positions which lie between the river's edge and the protective embankments, and the discouragement of forests (except in very exceptional circumstances) in areas

which can only derive a water-supply from Government canals. I favour very much the extension of "huris" over the country in irrigated areas, but I consider that such huris should be reserved rather as a source of food for goats and camels than as sources of fuel supply. Clumps of fresh young babul plantations over the countryside have merits other than utilitarian.

9. It is not necessary for me to venture to criticise the conclusions the Committee arrive at respecting the financial results of the Barrage projects. I am in perfect agreement with Messrs. Baker and Lane when they say that even though the final estimates of the cost of these works are so high as to make the project unremunerative yet are they necessary as protective works. The inundation of 1918 and its results give great force to that judgment.

I have the honour to be,

Sir,

Your most obedient servant,

F. WRIGHT,

Chief Engineer in Sind.

Accompaniment—

The Report on the Indus Barrage Projects.

CONTENTS.

Note.—The numbering of pages and paragraphs differs from the copy of the Report submitted to the Secretary of State.

CHAPTER I.

INTRODUCTORY.

1. A Project for the erection of a Barrage on the Indus at Sukkar, with a new canal on each bank and with certain consequent extensions of irrigation from the Eastern Nara, was prepared and submitted to Government in 1910. But it was rejected by the Secretary of State's Advisory Committee on the ground that as a protective work it was premature and as a productive work it was not certainly productive.

The Committee recommended, however, that a revised project should be prepared for the Barrage with canals on the right bank and left bank.

2. The weak points of the former project appear to have been these :—

(*a*) The estimated area of kharif cultivation was great while the estimated area of rabi was small. Since even dry kharif crops use about twice as much water as rabi crops and are on the whole less valuable this necessitated very large canals without an equally large revenue.

(*b*) On the right bank this difficulty was increased by the existence of great areas of rice and of waste lands too alkaline to grow anything but rice. It was considered very doubtful if a canal large enough to irrigate all this rice land could possibly be used for a much smaller rabi supply.

(*c*) The true area and situation of the cultivable waste land was quite uncertain.

(*d*) The estimates of revenue appeared low, considering the great rise of prices and the much higher rates paid on similar canals elsewhere.

(*e*) There was much disagreement about the duty of water, that is the acreage of each crop in each season which could be sufficiently irrigated by one cubic foot of water per second.

It was to consider remedies for these defects that our committee was appointed.

3. The first thing to be done was to remove the uncertainty about the cultivable waste, so that we should know with what area we were dealing. The existing record was generally believed to be worthless and this belief was not ill founded. Enquiry has shown that the old figures frequently bore no resemblance to the truth.

Government accordingly ordered a soil survey and attached to us for this purpose a staff consisting of two Deputy Collectors, six Mukhtyarkars and forty-two classers.

Work began early in February 1918, and finished almost exactly a year later ; but as a recess of 4½ months in the inundation was necessary the working season was little over seven months. During this time they surveyed all the waste land and much of the occupied fallow land in some twenty-five talukas, amounting to more than two million acres.

Considering the difficulties and hardships this may be considered a very creditable piece of work.

4. A mere twofold classification into cultivable and uncultivable areas seemed insufficient, as this would be difficult for us to check and would not give enough information to the engineer or the colonisation officer. Accordingly the land was classified fourfold as follows :—

A. Good.
B. Cultivable.
C. Cultivable with rice only (*i. e.*, fit to grow rice within two years).
D. Uncultivable.

B and D were further sub-divided according to their faults, such as kalar, surface sand, sand-bar or mounds.

It is probably true that with time and trouble, much water and some drainage, any kalar, land could be made fit to grow rice : and also that much of it, when it is fit to grow rice is fit to grow irrigated wheat. But to reclaim large contiguous areas of bad kalar is very difficult and to provide enough water for all such areas would require enormous and unprofitable canals. The distinction between C and D is therefore necessary for the Right Bank Canal.

5. The classification was, wherever possible, made in consultation with the local zamindars and ploughmen. In a few cases we have revised their opinions by that of better farmers on similar land elsewhere. But, generally speaking, B land is land which the men on the spot consider worth farming with dry crops.

In accordance with orders we also surveyed occupied lands which had not been cultivated twice in the last ten years ; but the result was not important since, although many fields had deteriorated, hardly any had gone below the B standard, and those were in rice dehs on the Right Bank where it mattered little.

6. The results of the Soil Survey are as follows :—

Left Bank.

A.	481,101 acres.
B.	277,380 acres.
C and D.	240,522 acres.
Total ..	999,003 acres.

Right Bank.

A.	290,433	432,667 acres.
B.	142,234	
C.	188,224	282,232 acres.
D.	94,008	
Total ..		714,899 acres.

7. The occupied area on the Left Bank being 1,739,353 acres the total cultivable area comes to very nearly 2,500,000 acres. Mr. Lucas' estimate of cultivable land in the same gross area was 2,039,000, but he excluded Jagirs which we have included, since they have to be irrigated ; the full figure would be about 2,120,000. Thus the soil survey has resulted in a gain of about 380,000 acres.

8. Dr. Summers' Left Bank Canal Project included on the extreme tail of the Canal certain areas in Guni and Tando Bago talukas, the former being reached by a syphon under the Fuleli Canal. These lands mainly grow rice at a very low rate of assessment and have a sufficient supply already. To bring a rice supply nearly 250 miles to such lands as these would be most expensive and certainly unprofitable either to Government, or to the zamindars or to both. We have, therefore, with the sanction of Government, excluded these lands from the project as well as a few similar adjacent villages in Taluka Dero Mohbat. The cultivable area in these lands was estimated in the former project as 93,000 acres.

9. On the Right Bank the occupied area is 1,391,000 acres and the cultivable total is about 1,822,000 nearly 300,000 above the figures of 1910. But the area dealt with is not the same. The former project included the lands between the river and the protective bund, which have now been excluded, and excluded lands in the sub-montane tract which can now be commanded. These latter lands are extensive and are almost virgin wheat soil, so their inclusion makes a great difference.

The figures given above are those of the lands actually surveyed ; the area finally brought under the project is about 50,000 acres less.

10. The information collected by us in the course of the soil survey will now be tabulated in registers and shown in detail on the large scale village maps. The alignment of water-courses and distributaries will thus be facilitated when the details of the canal projects are worked up.

11. The statistics of the present cultivation and revenue have been brought upto date, figures being taken for a period of ten years from 1908-09 to 1917-18, inclusive.

They are somewhat higher than the former figures, owing to favourable inundations, especially on the Right Bank, but the areas on that side are not identical.

It is unfortunate in a way that we could not include the figures of the present season. The fertile Larkana district is this year almost a desert and the revenue must be the lowest on record. The necessity of the project has never before been so obvious.

12. These statistics, which came from the Collectors, have given us much trouble. We had to make out all the totals and averages ourselves, since we alone know the country well enough to correct obvious errors. In the end they are perhaps as correct as Indian statistics usually are.

13. The areas to be irrigated by the projects are as under :—

Left Bank.

District.	Taluka.
Nawab Shah	Kandiaro.
	Naushahro.
	Moro.
	Sakrand.
	Nawab Shah.
	Shahdadpur.
	Sinjhoro. (That part which is not on the Jamrao.)
Hyderabad	Hala.
	Hyderabad.
	Tando Allahyar.
	Dero Mohbat. (Except a few villages.)
Thar and Parkar	Digri. (A small area transferred from the Jamrao.)

Right Bank.

District.	Taluka.
Sukkur	Sukkur. (A few villages.)
	Garhi Yasin. (Almost all.)
Upper Sind Frontier	Shahdadkot.
Larkana	Rato Dero.
	Miro Khan.
	Larkana.
	Kambar.
	Labdarya.
	Warah.
	Mehar.
	Kakar.
	Dadu.
	Johi.
	Sehwan.

except the land between the river and the bund, the mountains and part of the sub montane plain.

Eastern Nara.

District.	Taluka.
Nawab Shah	Sinjhoro.
Thar and Parkar .. .. ,.	Sanghar.
	Mirupur Khas.
	Jamesabad.
	Digri.
	Khipro.
	Pithoro.
	Umarkot.

CHAPTER II.

Duties, etc.

14. For the calculation of kharif supply we have considered two duties only, namely, for (*a*) the rice crop and (*b*) all dry kharif crops. The latter will comprise cotton, cereals, gardens, tobacco, etc.

(*a*) The best varieties of rice are now grown in the Larkana District in Sind, on the inundation canals, this crop forming a very large proportion of the total kharif cultivation on certain canals. Actual duties obtained on measured supplies at heads of these canals are as under. (Dry crops being counted as half their area under rice.)

Canal.	Kharif duty.	Proportion of rice to total kharif.
		Per cent.
Dhamrao Canal	40·7	86·0
Gawahar Wah	30·5	98·5
Raj Wah	42·9	98·6
Arthur Wah	28·2	97·3
Mondar Wah	27·1	98·9
Gul Mahomed Wah	44·9	92·4
Kur Matal	36·6	99·6
Average ..	36·3	95·9

The average discharge of these canals is 250 cusecs and they may therefore be taken as corresponding to the large distributaries of a modern canal system.

We adopt for the Sind projects of rice duty of 50 acres per cusec at outlet. Allowing for intermediate absorption losses this is equivalent to a distributary head duty of 43·5.

This figure is considerably higher than the average duty now obtained on inundation canals but we consider that the certainty of supply under the new conditions will allow of its being realized, the present low duties being chiefly due to excess watering at times of abundant supply as tending to tide over periods of deficiency.

The fact that a distributary head duty of 43·5 is now actually exceeded under present conditions on the Gul Mahomed Wah and is very nearly approached on the Dhamrao, a canal carrying an average discharge of 567 cusecs and irrigating an area of nearly 20,000 acres of rice crop, is we consider adequate proof that we have not pitched our duty unduly high. The Dhamrao grows superior rice and much water is expended in reclaiming kalar. Kalar once reclaimed requires less water than other soils and our main rice area is kalar. The Dhamrao is therefore typical.

(*b*) High cotton duties are obtainable with careful farming and economical irrigation, as evidenced by the results on the tenant-farmed plots at the Lyallpur Agricultural Station. The climatic conditions here, as regards hot weather temperatures and rainfall, are very similar to those of the greater part of the Rohri Canal tract. Results obtained at Lyallpur are :—

American Cotton (average of 10 series) duty 124.

Desi Cotton (average of 5 series) duty 121.

These figures represent duties on the field and the actual rainfall at Lyallpur amounted to seven inches, in each case, during the kharif period.

We find that the only useful local data for consideration of cotton duties are obtainable from the working of the Jamrao Canal. We have examined these figures over a number of years and have arrived at average results as under :—

Kharif duty at Jamrao Canal Head—69·3.

The full supply discharge of the Jamrao Canal is 3,200 cusecs and it is comparable to a large branch in a modern canal system. The first twelve miles of this canal run through sand and in this reach the absorption loss is very high, amounting to an average of 335 cusecs or nearly 14·2 per cent. of the canal head discharge. The normal loss in this reach would be 3·8 per cent. only of canal supply and under such conditions the Canal Head Duty would increase to 76·5.

Kharif duties at heads of branches of the Jamrao Canal (equivalent to distributaries of a modern canal system) are :—

Dalor Minor,	kharif duty	.. .. ..	83·7
Patoi	„ „	.. .. ..	101·1
Rind	„ „	.. .. ..	90·4
Sinjoro	„ „	.. .. ..	84·9
Puran	„ „	.. .. ..	93·7
Digri	„ „	.. .. ..	75·1
Murid	„ „	.. .. ..	75·7
	Average kharif duty	..	84·7

The average rainfall in the Jamrao tract, over the period covered by the above, was 7·74 inches and the cotton crop amounted to 66·4 per cent. of the total kharif cultivation.

We adopt an outlet duty of 100 acres per cusec for cotton and all other dry kharif crops.

This figure is very much lower than that which is obtained with careful farming at Lyallpur but it is slightly higher than the duty obtained under present conditions on the Jamrao Canal, the outlet duty of 100 decreasing to 87 at distributary head when allowance is made for intermediate losses of supply. Assured supply for early sowings in March-April and for final waterings in October is essential to successful cotton cultivation and these conditions do not now obtain on the Jamrao Canal. We consider that with certainty of supply at critical seasons, as will be insured by the Sukkur Barrage, the duties now obtained on this canal will undoubtedly be bettered. On the other hand we do not pitch our duty so high as the Punjab figure, the sun heat being there less severe and the rainfall less uncertain than in Sind. For the Punjab perennial canal projects a mixed kharif duty of 100 at distributary head is generally adopted and our corresponding duty of 87 thus allows of a liberal margin of supply.

15. We consider that the basis of canal design in Sind must be the kharif demand. In the Punjab this is not so, the rabi crop being the more popular. We certainly anticipate a large demand for rabi water developing in due course over the whole Rohri Canal tract, since even now no opportunities are lost of growing wheat in the greater part of this area, either as "bosi" where the soil is suitable and the sub-soil water not too low, or irrigated on wells.

The importance of fixing a definite figure as the rabi duty does not, however, arise since the necessarily large capacity of the canal, designed on the required kharif supply, will allow of the irrigation of rabi crops upto the limit which we consider probable or possible.

In the Punjab, the rabi duty is usually taken as double the kharif dry crop duty and we are of opinion that the same proportion may also be adopted for our Sind canals.

We therefore adopt a rabi outlet duty of 200 acres per cusec. Assuming that the deficit in cold weather rainfall is made up by one extra canal watering in Sind, our duty will agree very nearly with the actual rabi duties obtained on the Punjab canals.

16. To recapitulate the duties which we adopt for the Sind Project are :—

	Outlet.	Distributary.	Branch.	Canal Head.
Kharif, rice ..	50	43·5	40	36
Cotton, etc. ..	100	87	82·5	72·5
Rabi ..	200	174	165	145

17. In arriving at the equivalent values of the duties at the various points of distribution we have made approximate allowances for the loss of supply, due to evaporation and absorbtion, at a rate of twenty per cent. between the main canal head and the distributary and at fifteen per cent. thence to the outlets. These allowances very nearly agree with the generally accepted basis of calculation at eight cusecs per million square feet of wetted canal surface. The actual losses can only be arrived at after the sections of the canals, branches and distributaries have been worked out and the differences should be inconsiderable and the duties at the various stages of the canal systems not materially affected.

18. In the design of the modern perennial canals of the Punjab it has been the practice to allow 25 per cent. " Extra Supply " over and above the estimated requirements to meet the extra demand at periods of overlap of the kharif and rabi crops. Experience shows, however, that this " Extra Supply " is not kept as a reserve and that actually when a canal has once been run at its full capacity to meet the heavy demands of its fully developed irrigation, full capacity is thereafter worked upto and is fully utilized as long as it can be made available from the rivers.

The designed maximum supply thus becomes the normal full supply of the canal and no reserve can be provided at critical periods of overlapping of crops.

We do not therefore consider that any empirical percentage allowance of extra supply can be justifiably adopted in designing the Sind canals and we have accordingly examined this question from the point of view of the actual irrigational requirements of our crop forecast for each month in the year.

We provide for seventy per cent. of the final cotton area as requiring irrigation in March, while during this month provision is also made for sixty per cent. of the rabi area as being still under irrigation. The March discharge is thus the maximum. At the second period of overlap in October, we assume that eighty per cent. of the cotton area will require its final waterings and we also provide for sixty per cent. of the rabi area as coming under irrigation.

The percentage adopted allows of the probable maximum of early cotton sowings and only in a mild season would so large a proportion of the crop be still irrigated in October. In our opinion the later watering of cotton should be discouraged as being uneconomical, the small extra outturn of seed cotton resulting therefrom, being disproportionate to the outturn of wheat which would be obtained from early sowings on the water-supply so utilized.

19. The monthly discharges required on the above basis at head of the Rohri Canal are tabulated in the annexed Discharge Statement. It will be seen that the maximum required discharge (March) amounts to 10,138 cusecs, while the normal kharif discharge, to irrigate cotton and other dry crops only, would be 9,448 cusecs.

The actual overlap, or difference between maximum and normal kharif discharges, would thus amount to 690 cusecs or an allowance for extra supply of 7·3 per cent. only.

In order to utilize this available surplus during the kharif season we provide for an area of 24,000 acres of rice, a crop requiring irrigation only during the five months May to September and thus not affecting the demand at the two critical periods. The existing area of rice on the Left Bank is about 23,500 acres so the surplus provides for it all.

Statement showing discharge required at Rohri Canal Head for each month during the year.

Month.	Kharif.						Rabi.			Total Supply required at Canal Head.
	Cotton and other dry Kharif.			Rice.						
	Permissible area.	Anticipated area under irrigation during the month.	Supply required at duty 72·5.	Permissible area.	Anticipated area under irrigation during the month.	Supply required at duty 36.	Permissible area.	Anticipated area under irrigation during the month.	Supply required at duty 145.	
			Cusecs.			Cusecs.			Cusecs.	Cusecs.
January	6,85,000 acres	....	....	24,000 acres.	....	....	1,350,000 acres	100 per cent. 1,350,000 ..	9,310	9,310
February		....	....		....	....		100 per cent. 1,350,000 ..	9,310	9,310
March		Nearly 50 per cent. 330,000..	4,552		....	....		60 per cent. 810,000 ..	5,586	10,138
April		90 per cent. 616,500	8,503		30 per cent. 7,200 ..	200		10 per cent. 135,000 ..	931	9,634
May		100 per cent. 685,000 .	9,448		75 per cent. 18,000 ..	500		....	....	9,948
June		100 per cent. 685,000..	9,448		100 per cent. 24,000 ..	666		....	....	10,114
July		100 per cent. 685,000.	9,448		100 per cent. 24,000 ..	666		....	....	10,114
August		100 per cent. 685,000..	9,448		100 per cent. 24,000 ..	666		....	....	10,114
September		100 per cent. 685,000..	9,448		100 per cent. 24,000 ..	666		....	....	10,114
October		Nearly 47 per cent. 320,000	4,414		....	....		60 per cent. 810,000 ..	5,586	10,000
November		....	....		....	....		90 per cent. 1,215,000 ..	8,379	8,379
December		....	....		....	....		100 per cent. 1,350,000 ..	9,310	9,310

Note.—(1) Assumed kharif area permissible.

Cotton	..	400,000 acres.
Other dry crops	..	250,000 ,,
Leguminous ..	..	35,000 ,,
Rice	..	24,000 ,,
Total	..	709,000 ,,

(2) Assumed Kharif areas under irrigation.

In March.			In October.		
Cotton 70 per cent. ..	..	280,000 acres.	Cotton 80 per cent. ..	..	320,000 acres.
Other dry crops ..	..	50,000 ,,			
Total..		330,000 ,,			

CHAPTER III.

LEFT BANK CANAL.

20. Although the area to be irrigated by the Left Bank Canal is now some 400,000 acres more than estimated in the former project yet we have been able to reduce the discharge of the canal by more than 4,000 cusecs.

This has been done not by raising the duties, for our duties differ little from those of Dr. Summers, but partly by reducing the overlap margin and partly by assuming a higher proportion of rabi to kharif crops.

Detailed enquiry showed that, as explained above, the margin really required for the overlap of cotton and rabi crops was very much less than the traditional 25 per cent. and that since there was no overlap during the rice season, it was possible to use the whole margin as a rice supply.

21. The former project fixed the kharif intensity at 35 per cent. while ours is 27 per cent.; but since our area is greater the actual area provided for in kharif is little less. The greatest proportional reduction is in rice. The former project assumed a considerable increase of rice. We propose to provide for all existing rice but for no increase. There is hardly any land on this side which always does grow rice and can grow nothing else; inferior kinds are general, and even for these, tenants are imported from the Right Bank. The latter is the real rice country and will be treated as such.

Rice is the least profitable crop in a project of this kind. Cotton is 50 per cent. and wheat 100 per cent. more profitable. Therefore even apart from the risk of water logging it is not desirable to extend rice on the Left Bank.

22. Our reasons for anticipating a higher proportion of rabi have already been submitted to Government and approved (Government memorandum, Public Works Department, No. W. I.-65-M., dated the 4th January 1919). They may be briefly repeated as follows. Central and Lower Sind at present grow little rabi, and it was formerly thought that this was because the people did not like it and did not understand it. But a tour in the rabi season of 1917-18 showed that the real reason was lack of opportunity.

That year the opportunity came and they took full advantage of it, well-tilled fields of wheat being found almost wherever practicable, even in the southernmost part of the area. In the northern part wheat was always popular and in some places there are wells in almost every field. The fact that the present scarcity of millet has taught many men to eat wheat for the first time is an additional reason. Consequently we felt justified in taking a much more hopeful view of rabi prospects than Mr. Lucas took under the different circumstances of 1910. However, we estimate for the first decade only 500,000 acres against Mr. Lucas' 350,000, and for the second decade little more than half what is possible.

23. We have allowed in our calculations for 400,000 acres of cotton annually. Mr. Lucas' estimate was about the same. This is a proportion of cotton to other dry kharif crops of about 10 to 7, the present proportion being 2 to 7 (Cotton 118,000 acres). As this part of the country grows especially good millet crops and millets are the food of the people, we do not expect this proportion of cotton to be exceeded in the present generation. But the discharge of the canal will be sufficient to grow 735,000 acres of cotton if necessary. The intensity of cotton would then be 27 per cent. of the cultivable area and nearly 500,000 acres of wheat would still be possible.

24. The land of middle Sind is considered by experts to be some of the best cotton soil in the world and the climate of the southern portion gives the crop a long season. It has therefore been suggested that since the Left Bank is intended by nature for a cotton country we ought to design the canal for 50 per cent. of available area under cotton, to be watered all the year round.

25. But there are very strong reasons against this. In the first place, we have to base our estimates on probabilities not on ideals. For the reasons given above, we think the 27 per cent. intensity of cotton for which our design provides, to be beyond the limits of probability in this century. 735,000 acres is a very high figure, and it might be brought up to a million acres by the Right Bank Canal and the Nara.

Secondly, if it were probable it would not be profitable. Without going into details, it is enough to say that, since the rabi duty is double the kharif duty, cotton cannot pay as well as wheat unless it is assessed at double the wheat rate. But nobody has proposed a higher rate on cotton than Rs. 8 while our wheat rate is Rs. 6. It is not necessary to say anything of the profits of the zamindars because our rates are naturally based on our estimates of those. But, since it is also proposed that cotton should use the rabi water as well, the case is even stronger than this: it would have to pay the rabi rate as well and that would come to Rs. 18 per acre in all.

26. If the canal were designed for 50 per cent. cotton, it must be almost double in size and cost and must run half empty in the cold weather. It would not be possible to use the spare water for irrigating wheat because the cotton and wheat seasons overlap in March and October, when it is too hot for watering on the winter scale. Besides to run it full in the cold weather would use up nearly the whole Indus discharge, leaving nothing for the Right Bank.

27. Of course a figure lower than 50 per cent. but higher than 27 per cent. might be taken. But the fact remains that the further one goes from the ideal of two acres of rabi to one of kharif the greater the engineering difficulty and the less the profit. Our proposals on this subject were accepted by the conference of December (November?) 1918, when the Imperial Agriculturist was present.

28. From the other direction our cotton estimate might perhaps be criticised as not allowing enough kharif food crops for a millet eating population. But we allow 250,000 acres and from the present area of 350,000 acres with a less assured water-supply these districts export very large quantities. Besides, it has already been shown that the people are likely to eat wheat when they have it. Probably at present one-third of the whole population commonly eats wheat and rice, and 250,000 acres should certainly produce a pound a day of millets for each of the others.

29. Some leguminous crops in kharif are expected from the first. "Gwar" is already a common crop in certain light soils near Nawab Shah, and it is hoped that at a low assessment it will spread a good deal.

30. The present population of the Left Bank area is about 900,000. Statistics of the agricultural population are conflicting and untrustworthy, but it seems safe to assume that one in every four is a male working agriculturist. Our estimate of cultivation in the second ten years is 700,000 acres kharif and 800,000 acres rabi, which comes to 3·1 acres per man in kharif and 3·5 in rabi, or 6·6 in all. This is below the actual figure of the Jamrao and certainly below what is possible. Consequently, there is no immediate necessity for immigration. What is necessary is to spread out the population and colonise the district from within itself.

At present owing to variations of soil and water and to the prevalence of lift irrigation, which makes double work, the population is much more intense in some places than will be necessary in future. Many men in such places are very skilful but also prosperous and therefore not easy to move. However, the question of colonisation will be treated later. At present it is enough to say that our estimates require no immigration within twenty years.

31. Our revenue estimates for the Left Bank are based on the following rates :—

Crop.	First 10 years.	Second 10 years.	Third 10 years.
	Rs. a. p.	Rs. a. p.	Rs. a. p.
Rice	7 0 0	8 0 0	9 0 0
Cotton	5 8 0	6 8 0	7 0 0
Other kharif	4 0 0	4 0 0	4 8 0
Rabi (wheat and oilseeds)	5 0 0	6 0 0	6 0 0
Leguminous, kharif or rabi	2 8 0	3 0 0	3 0 0

Watered dubari to pay ordinary rates. Unwatered-free.

The appended statement is intended to explain and justify these rates.

Left Bank.

Incidence of assessment on zamindar's assets (i.e., Half Net outturn).

Crop.	Average outturn maunds per acre.	Price pre maund.	Value.		First Rate.	10 years Incidence.	Second Rate.	10 years Incidence.	Third Rate.	10 years Incidence.	Rate at 40 per cent. of Assets.
		Rs. a. p.	Rs. a. p.		Rs. a. p.	Per cent.	Rs. a. p.	Per cent.	Rs. a. p.	Per cent.	Rs. a. p.
Rice, Sugdasi	25	3 0 0	75 0 0	60	7 0 0	23·3	8 0 0	26·6	9 0 0	30	12 0 0
Sathri	17	2 12 0	46 0 0								
Cotton	6	9 0 0	54 0 0		5 8 0	20	6 8 0	24·4	7 0 0	26	10 12 0
Other Kharif Juar	10	3 0 0	30 0 0	30	4 0 0	26·6	4 0 0	26·6	4 8 0	30	6 0 0
Bajri	9	3 4 0	29 4 0								
Rabi, Wheat	10	5 0 0	50 0 0	44	5 0 0	22·7	6 0 0	27	6 0 0	27	8 12 0
Rape	7	5 8 0	38 8 0								
Gram	6	4 0 0	24 0 0		2 8 0	21	3 0 0	25	3 0 0	25	4 12 0

32. The estimates of outturn are based on personal observation and on the experience of various settlement officers. They are intended to represent average crops in normal seasons with an assured water-supply. The prices are, of course, not war prices but a little higher than pre-war prices. It seems improbable that actual prices in future will ever fall below them.

33. If the rates seem high compared with existing rates it must be remembered that they are for an assured water-supply instead of a precarious one. Besides, rates in Sind have always been below the settlement standards of other provinces. They were first fixed when prices were exceedingly low and have failed to keep pace with subsequent rises. This is especially the case with the rice rates. It is worth mentioning that our initial rice and other kharif rates are already exceeded in some talukas in Sind, and our rabi flow rate is little above present rabi lift rates.

Our cotton rates are higher than any present ones. But existing cotton is mostly irrigated by lift and has, except on the Jamrao, only half as long a season as it will have on this canal. Considering this, that cotton is now worth more than Rs. 20 per maund and that good crops yield ten to fifteen maunds per acre, our estimates are surely cautious enough ; yet even so, cotton will be the most lightly assessed crop.

34. We allow double water for rice, so the rice rate is double the dry crop rate. Unwatered dubari crops after rice are grown without extra water, so no extra rate need be assumed.

35. The Collectors have been consulted about these rates and show general agreement. One of them suggested that the rice rate was too low ; the rate then proposed for the first ten years was Rs. 6-8-0 per acre and it has now been raised to Rs. 7 per acre.

36. The appended statements show estimates of cultivation and revenue for three periods of ten years each.

The first two of these we regard as certain of attainment. Even in the second period the intensity of exhausting crops is only 57·4 per cent. a rate already exceeded in many villages without the help of rice or restorative crops.

The estimate for the third period shows the full intensity of the project and we do not pretend to guarantee it. But it seems quite possible and will no doubt be attained in time. Some of the Punjab Canals reached it in a good deal less than twenty years. It will require improved tillage and increased use of leguminous crops. Perhaps barsim may not become so popular here as was at one time hoped : but numerous other leguminous crops, both kharif and rabi, are known in certain parts of Sind and may easily be spread here—indeed the process has already begun on a small scale.

37. Detailed estimates in the prescribed form are not possible at this stage, because the canal has to be designed afresh. The main features of Dr. Summers' design will no doubt stand ; but it has to be reduced to suit the lower discharge and it must, in accordance with the latest orders, be worked out from the tail water-courses upwards. It is impossible, therefore, at this stage to say exactly what the profit will be since we do not know the cost nor the time required for construction.

We have, however, made rough estimates, calculating the cost per cusec at the same rate as Dr. Summers, but adding for enhanced rates of labour and material 20 per cent. on the canal and 10 per cent. on the Barrage. As Dr. Summers' rates were fairly liberal this will be perhaps as near as we can get in these days of uncertain prices. These rates include all direct and indirect charges and excess of interest over revenue during construction.

38. The rates of present and future working expenses are the same as in the former project.

39. The figures of present revenue are up-to-date and are higher than before.

40. The deduction for Jagirs is made on the assumption that Jagirs will pay as water rate half the ordinary rate in rabi but only a quarter in kharif. As these Jagirs have always had a kharif supply it is not possible to impose a high rate in that season. But the rabi supply is unearned increment, which they can take or leave as they like.

41. We have not deducted anything from the revenue on account of what is called the "Land Revenue Share". Land revenue and water revenue in Sind are really one and indivisible. But for certain account purposes it has been found convenient to set up the fiction that $\frac{9}{10}$ths of the amount is water rate and $\frac{1}{10}$th land revenue : and from this some people have inferred that the $\frac{1}{10}$th assigned to Land Revenue must not be included in the estimates of a canal project.

This might be reasonable if we were dealing with a country where land produced crops without irrigation, though the fact is that in such countries land revenue and water revenue are really separate things, fixed at separate rates. But in Sind where the rainfall is negligible it is quite different. There is, it is true, such a thing as "Barani" cultivation. But it amounts to hardly anything in the area now concerned, except in the submontane region on the Right Bank and even there the project hardly touches the country where barani crops are common.

The average value per acre of land in our area, apart from irrigation, cannot be expressed in any existing currency since the cowrie has gone out of use.

It is open to anyone who wishes to do so to divide the revenue by 10 and assign the respective shares to the account heads of Public Works and Land Revenue. No doubt it will be so divided in the accounts after (though not before) it is received. It is not necessary for us to do it, these account distinctions being irrelevant to our purpose.

But to ignore or deny the very existence of the odd one-tenth is quite a different thing. We know that Government will get the whole of that sum and will get it from the project: with the project they will get all and without the project they will get none. If we excluded it, therefore, our estimates would be false, and we do not think it right to falsify our accounts for the sake of an account fiction and a fallacy.

42. Our estimates assume the construction within a reasonable time of the Left Bank Light Railway which has already been projected. There can be no doubt that this very promising line will be built. It would pay even under present conditions because the North Western Railway, in its anxiety to get cheap land, left nearly all the fertile and populous part of the country untouched.

Left Bank Canal.

Cultivation and Revenue.

Occupied Area.	Rice.	Cotton.	Other Kharif.	Rabi.	Dubari.	Total Kharif.	Total Rabi.	Total Annual.	Gross Revenue.
Present.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Rs.
1,665,000	23,500	110,000	403,000	119,500	17,000	544,500	136,500	681,000	18,96,000
Proposed.									
First ten years	24,000	300,000	385,000	505,000	....	709,000	505,000	1,214,000	57,98,000
Second ten years	24,000	380,000	305,000	800,000	....	709,000	800,000	1,509,000	82,87,000
Third ten years	24,000	400,000	385,000	1,350,000	....	709,000	1,350,000	2,059,000	1,14,32,000

Intensities.

Present (without Dubari).	per cent.	Proposed First ten years.	per cent.	Second ten years.	per cent.	Third ten years.	per cent.
Kharif	32·6	Kharif	28·4	Kharif	28·4	Kharif	28·4
Rabi	7·2	Rabi	20·2	Rabi	32·0	Rabi	54·0
Annual	39·8	Annual	48·6	Annual	60·0	Annual	82·4

Without Rice and restorative crops.

	47·2	56·4	79·0

Gross Revenue.

First ten years—

	Acres.	At Rs. a. p.	Rs.
Rice	24,000	7 0 0	1,68,000
Cotton	300,000	5 8 0	16,50,000
Other kharif	380,000	4 0 0	15,20,000
Kharif, leguminous	5,000	2 8 0	12,500
Rabi	500,000	5 0 0	25,00,000
Rabi, leguminous	5,000	2 8 0	12,500
			58,63,000
		Deduct Jagirs	65,000
		Gross Revenue	57,98,000

Second ten years—

	Acres.	At Rs. a. p.	Rs.
Rice	24,000	8 0 0	1,92,000
Cotton	380,000	6 8 0	23,70,000
Other kharif	280,000	4 0 0	11,20,000
Kharif, leguminous	25,000	3 0 0	75,000
Rabi	750,000	6 0 0	45,00,000
Rabi, leguminous	50,000	3 0 0	1,50,000
			84,07,000
		Deduct Jagirs	1,20,000
		Gross Revenue	82,87,000

Third ten years—

	Acres.	At Rs. a. p.	Rs.
Rice	24,000	9 0 0	2,16,000
Cotton	400,000	7 0 0	28,00,000
Other kharif	250,000	4 8 0	11,25,000
Kharif, leguminous	35,000	3 0 0	1,05,000
Rabi	1,100,000	6 0 0	66,00,000
Rabi, leguminous	250,000	3 0 0	7,50,000
			1,15,96,000
		Deduct Jagirs	1,64,000
		Gross Revenue	1,14,32,000

Net Revenue.

First ten years—

	Rs.
Gross Revenue	57,98,000
Add 5 per cent. interest on Malikano, 240,000 acres at Rs. 10	1,20,000
Add Forest Revenue, 13,000 acres at Rs. 1-8-0	19,500
	59,37,500
Deduct Present Revenue	18,96,000
	40,41,500
Deduct Working Expenses—1,214,000 acres at Re. 1·2 less 681,000 acres at Re. ·96	8,03,040
Net Revenue	32,38,460

Second ten years—

	Rs.
Gross Revenue	82,87,000
Add 5 per cent. interest on Malikano	1,20,000
Add Forest Revenue	19,500
	84 26,500
Deduct Present Revenue ..	18,96,000
	65,30,500
Deduct Working Expenses—1,509,000 acres at Re. 1·2 less 681,000 acres at Re. ·96	11,57,040
Net Revenue ..	53,73,460

Third ten years—

	Rs.
Gross Revenue	1,14,32,000
Add 5 per cent. interest on Malikano	1,20,000
Add Forest Revenue	19,500
	1,15,71,500
Deduct Present Revenue ..	18,96,000
	96,75,500
Deduct Working Expenses—2,059,000 acres at Re. 1·2 less 681,000 acres at Re. ·96	18,17,040
Net Revenue ..	78,58,460

Percentage of Return on Capital Cost.

	Rs.
Discharge, 10,138 cusecs.	
Cost of Canal at Rs. 4,277 per cusec	4,33,60,226
(Dr. Summers' cusec rate *plus* 20 per cent. including all direct and indirect charges and excess of interest over reveune during construction.)	
Add Half cost of Barrage	1,37,50,000
(Original Estimate, Rs. 2,50,00,000 *plus* 10 per cent.)	
Total Cost ..	5,71,10,226

First ten years—

Net Revenue 32,38,460

Return on Capital Cost, 5·67 *per cent.*

Second ten years—

Net Revenue 53,73,460

Return on Capital Cost, 9·41 *per cent.*

Third ten years—

Net Revenue 78,58,460

Return on Capital Cost, 13·76 *per cent.*

CHAPTER IV.

Right Bank Canal.

43. The special difficulties of the Right Bank area have already been briefly stated. The country consists roughly of three tracts. The central tract, extending from near Dadu north to the neighbourhood of Shadadkot, is almost entirely alkaline. The southern end is the barren kalar familiar to passengers by the Quetta Mail. The rest includes the famous "Mail Mulk" and the magnificent rice country which has spread from that centre.

44. The eastern tract, running from Sehwan to Sukkur, is silty riverain land. Rice and kalar have recently encroached on it, but in general it is suitable for intensive wheat growing. The western tract consists of the sub-montane slope and the valley where this meets the opposing riverain slope. The soil here is sweet loam or clay, fit to grow anything, but hard to irrigate because of the hill floods and the steepness of the slope towards the mountains.

45. Even the Left Bank is very far from being a "tabula rasa" but the Right Bank, or most of it, is a prosperous and highly irrigated country. Yet it is not desirable to "let well alone" and exclude it from the project.

For one thing it would not really be letting well alone, because in these days things are very far from being well on the tails of the canals, where a formerly prosperous country is reverting to desert,—both for other reasons and because of the increase in rice higher up.

Secondly, it is not even possible to exclude it, because the Barrage might shut off water from the existing canals at a critical time of the inundation.

46. It was therefore decided that the Right Bank area must be included but, as any regular canal project there seemed difficult and unremunerative, as little should be done as possible, *i.e.*, nothing beyond the construction of a feeder from the Barrage to the Ghar and Western Nara Canals near Larkana. But this we showed to be impracticable. The difficulty is that the Western Nara, besides its chief mouth above Larkana, has two other mouths lower down the river. Besides, much of the land in Dadu and Sehwan is not on the Nara at all, but on half a dozen minor canals taking off direct from the river. Obviously the supply for the lower Nara and minor canals could not be brought from the Barrage unless the Nara was considerably widened for a length of 50 or 60 miles. This would be expensive and difficult, because the banks are covered with houses and orchards. It would also be unsatisfactory, because the present channel is a series of curves and loops and the lower reaches are in a valley. It followed that at least one hundred miles of new canal were necessary, and probably much more; and that being so, one might as well do the thing thoroughly and make a whole new canal, which would earn new revenue and not merely keep present revenue going. Then came in the difficulty of combining a very heavy kharif supply for the central area with a much smaller rabi supply for the other areas. It had long been agreed that the replacement of rice by rabi in old established rice areas could not be expected. Certainly one canal could not make this combination, for it would run less than half full in rabi and even then would waterlog the central rice country.

But the area lends itself to convenient treatment by three separate canals,—one to run in the kharif season only to supply the rice tract and two independent perennial canals to command the northern and southern areas. The three canals would derive their supply from a single large feeder taking off above the Barrage and running for about 15 miles parallel to the railway line down to the neighbourhood of Ruk where the Northern Canal would branch off. The main canal would then continue, parallel to the railway, to about its forty-second mile where it would bifurcate into the Central Kharif Canal and the Southern Perennial Canal.

A map of the Right Bank area, to scale four miles to an inch, accompanies this report in illustration of our proposals. Details of design of the Right Bank system of canals will of course require investigation and elaboration and it may be that separate heads from above the Barrage to each of the three canals may be preferable to one great feeder canal.

47. The discharges of the three canals will be:—

	Kharif.		Rabi.	
Central Canal	9,487	cusecs.	*Nil.*	cusecs.
Northern Canal	3,906	„	3,404	„
Southern Canal	2,820	„	2,529	„
Total Discharge ..	16,213	„	5,933	„

The Central and Northern Canals are fairly normal in design. The latter begins working at once and reaches its main area in about fifteen miles. The Central Canal runs idle for about 40 miles, but then disposes of its heavy supply very rapidly, probably through existing canals, so that little new construction will be necessary.

The Southern Canal, on the other hand, irrigates only a rather narrow strip until about its 90th mile. Owing to this unusual design construction may be expensive, though not necessarily more expensive than that of the Left Bank Canal, which irrigates nothing whatever above its 50th mile. But even if it is expensive it will effect its object, as no smaller scheme can do. It will give the present cultivated area the supply best suited to it, and it will reach large areas of virgin wheat land. We hope to show that the consequent increase of revenue will more than cover the expense.

48. The calculation of intensity on the Right Bank is by no means a simple matter. Uniform intensity is impossible because of the prevalence of rice. We do not know how much rice will be grown. In some places perhaps the whole of the "Other Kharif" water will be used for rice, thus reducing the kharif intensity and increasing the possible rabi intensity.

We have accordingly fixed the proportions somewhat roughly village by village, with a view to keeping the kharif and rabi discharges as nearly equal as possible.

We have, however, generally assumed a somewhat high intensity of dry crops on the Right Bank, because the people are already accustomed to leguminous second crops and there is land where it is now usual to grow wheat or wheat and juari continuously without fallows.

49. In the greater part of the Northern area and much of the Southern area it has been necessary, in order to make the canals workable, to cut down the rice supply by one half. The following facts justify this:—

(*a*) It is almost all new rice. The amount for which we provide is usually as great as that which existed ten years ago.

(*b*) This new rice was obtained at the expense of the tail zamindars, who are thereby now being ruined. It is therefore reparation.

(*c*) The land is nearly all fit for wheat and used to grow wheat, and some has reverted to wheat this year. It is not like the alkaline Central area.

(*d*) In most Dehs more rice can be grown if required by using the other kharif supply.

(*e*) Many zamindars have been consulted and none object.

50. The figures on which the discharges of the canals are based are not quite the same as those taken for the revenue estimates. The former were based on existing cultivation, while the latter provided for some extension of rice where it is not now common. This change within the limits of the kharif supply will do no harm. The former figures might have been altered so as to agree with the latter but as it did not affect the discharge it was not worth while to do so.

51. We expect a certain amount of cotton on the Right Bank. There is no taluka even now without one or two acres, though it is nowhere common except in parts of the foot-hill country outside the area. This latter fact incidentally disproves the theory that the hot winds from the foot hills spoil cotton.

52. On the Central Canal we have provided a supply sufficient for 341,000 acres of rice. Probably most of it will be used for rice, though no doubt other crops will continue on some high lands. This far exceeds the present acreage of rice in this area. It could be largely increased by including kalar lands of Class C. But with very few exceptions we have included only A and B lands. It is not possible to irrigate the whole gross area,—some land must be left for drainage. The reclamation of kalar land takes a great deal of water at first and would require an enormous canal. Even as it is the Right Bank Canal, if its three parts are counted as one, will be the biggest canal in the world.

It is true that the greater the new area the greater proportionally is the excess of new revenue over the present: but in no case can a pure kharif canal on a barrage be a very profitable investment. It seems better to spend labour and money on a four-fold area of sweet land elsewhere.

The possible acreage of rice on the whole Right Bank system is 552,000 acres, the probable about 465,000 acres and the present 385,000 acres. This seems enough even for a famous rice country.

53. The high proportion of rabi requires no explanation. Conditions here approximate to those of the Punjab and wheat has always been popular.

54. The total intensity is not very important on the Right Bank, since 100 per cent. is quite normal for rice land, even without counting "dubari". We have therefore shown also the intensities without rice. The figures are repeated here for convenience:—

	First ten years. Per cent.	Second ten years. Per cent.	Third ten years. Per cent.
Total intensity	70	73·2	88·5
Intensity without rice	59	63·7	84·5
Intensity without rice and restorative crops	59	62·2	83

As in the case of the Left Bank the figures for the third period are less a forecast than a statement of what the canals can do when working to their full extent. They seem quite possible, however, though perhaps more leguminous crops will be wanted. The figures for the first two periods we regard as certainties.

55. The existing population is 765,000 of which one-fourth is 191,250. The number of acres per agricultural male is therefore—

	First ten years.	Second ten years.	Third ten years.
Kharif	3·5	3·6	3·7
Rabi	2·8	3·1	4·5
Total ..	6·3	6·7	8·2

This is well within the capacity of the present population for the first twenty years. After that some immigration may be wanted, not because the figures are excessively high but because the kharif and rabi are not in the same places.

We have included the whole population of the Larkana District because the people of the mountains, the submontane plain and the riverside outside the area will mostly work inside the area from the very first.

56. It has been proposed to take a branch from the proposed Right Bank Canal near Ruk to give perennial irrigation to the following additional areas :—

Sind { Garhi Yasin, 3 Dehs.
Shikarpur, 3 Dehs.
Jacobabad, 46 Dehs.

Baluchistan, Nasirabad—64 Dehs.

A rough Soil Survey has been made of the area in Sind, which appears to contain 108,660 acres of occupied land and 20,875 acres of cultivable waste. In Baluchistan the gross area is just over 200,000 acres. In the Nasirabad Canal Project 90 per cent. of this has been assumed to be cultivable : but we consider it quite safe to put the percentage at 95, since kalar and sand hardly anywhere extend beyond the frontier. The total cultivable land under command is therefore 320,035 acres.

This area is, however, anything but homogeneous. It consists of three parts. The southern part contains the Garhi Yasin and Shikarpur Dehs and nine Dehs of Jacobabad which are outside the regular rice area. In this rabi irrigation is possible. The central area contains the remaining Jacobabad Dehs. Throughout this part rice everywhere predominates enormously, and much of the waste is waterlogged.

The northern part contains the Baluchistan Dehs. The land will grow anything though not perhaps at the highest intensity, and is at present very badly irrigated.

We have no hesitation in saying that perennial irrigation is impossible in the central tract.

The extent of seepage and the height of sub-soil water are very great even in a dry year like this. Even if it were physically possible to convert the land from rice to rabi it would not be politically possible. The people do not want the new canal : if the change is accompanied by a rise of assessment they will no doubt agree with the Deputy Commissioner in calling it an " unmitigated nuisance." The Begari works very fairly well here and will do better when relieved of its tail by the Shahdadkot Branch. Their rice is mostly older than that of Rato Dero and Miro Khan, where we have proposed to reduce the rice acreage, calling it " reparation." Here it would not be reparation, because instead of going to the tail zemindars the water would go to transfrontier tribesmen for land which either has no right to water or else takes water from karias above the main rice area. The only way is to treat the central area as we have treated the Central Area of the Larkana District, and irrigate it in kharif only. The canal must flow past it with closed sluices all the rabi season in order to reach the northern area. According to our calculation the discharge of the canal will be 3,180 cusecs in kharif and 820 cusecs in rabi.

In our opinion this large discrepancy between the full capacity and the small supply required in rabi, in the upper and tail reaches only with no intermediate irrigation, will create great difficulty in distribution and make the perennial working of the canal an unworkable proposition.

Estimates of cultivation and revenue are attached. Assuming cost on the scale which we have assumed elsewhere the profit will be very low, especially if a share of the Barrage is included. We have assumed the same rates for Sind as on the Right Bank Canal Project, though it is doubtful if such high rice rates are justified. For the Baluchistan portion we have taken full rabi rates, though the Political Officers will perhaps not agree to them. Three-quarters of the Baluchistan revenue is credited, as has been done in the Nasirabad Canal Project.

It appears certain that water cannot be spared for this branch, since rabi irrigation in Sind, when it reaches its full extent, will take the whole of the normal minimum discharge of the Indus and that minimum may become lower and of longer incidence after the Sind Sagar Canal is opened.

We have seen the alternative project of the Nasirabad Canal and we prefer it. It pays better even if the low rates are not raised, as perhaps they might be. From a political point of view, which is very important considering the feeling between Rojhan Jamalis beyond the border and the Burdis on our side, it is far preferable, because it gives the former a water supply of their own without in any way disturbing the latter.

We subjoin a copy of a letter concerning this project from the Deputy Commissioner, Upper Sind Frontier.

Extract from letter No. 712, dated the 26th February 1919, from J. W. Smyth, Esq., I. C. S., Deputy Commissioner, Upper Sind Frontier :—

"I have the honour to state that this is the first that I have heard of the proposal to take a branch of the Right Bank Canal through Jacobabad Taluka, and that I am not aware what considerations have been put forward in support of it. Jacobabad Taluka is with the negligible exception of the Desert Canal entirely irrigated by the Begari Canal and even at the present time receives sufficient water to enable extensive rice cultivation to be undertaken. The area under this crop increases. The Begari supplies the Edan Wah with its water for Shahdadkot Taluka and irrigates one or two Dehs of that Taluka near Garhi Khairo by direct karias. It also supplies, *via* the Nurwah, Jhatpat and a portion of Nasirabad Tahsil with water. Now with the construction of the Right Bank Canal and its Branches, the Edan Wah will be no longer required, and the scheme for the Kalat or Nasirabad Canal which is to take off from the 19th mile of the Desert Canal provides for the irrigation of that part of Nasirabad Tehsil which is now supplied by the Nurwah.

"Therefore when these two new canals are constructed the Begari will have a much larger supply of water at its disposal than it now has, and although schemes are I believe being considered for a branch taking off at the 19th mile (the Sonwah Regulator) and irrigating the Shikarpur and Garhi Yasin Talukas and another from near the railway bridge to irrigate the north-west portion of Jacobabad Taluka, still it is probable that there will be a large surplus of water flowing to Garhi Khairo and that it will be available for the areas on both sides of the canal. At present it is only the dehs adjoining the Garhi Khairo-Shikarpur road that have at all a deficient supply, and this should be remedied by this surplus quantity. The rest of the tract is extremely prosperous.

"2. I am therefore unable to see that this proposed branch is required for Jacobabad Taluka, and if it is to be purely reserved for the country over the border, its passage through Jacobabad Taluka will be little else than an unmitigated nuisance. I am of course unaware what obligations have developed upon the Sind authorities to provide water for the Jamali and Magsi country beyond Garhi Khairo. But the scheme seems to me fraught with great possibilities of political confusion and misunderstanding with Baluchistan. I was under the impression that the proposed canal *ex* the Desert Canal was to extend to this country.

"It seems on the surface a pity to have two irrigation systems (presumably under the charge of two distinct Engineers) supplying the same tract of country, and that, a country of so peculiar a constitutional status. ....."

KALAT BRANCH.

Present Cultivation and Revenue.

Taluka or Tahsil.	Occupied area.	Rice.	Other Kharif.	Rabi.	Dubari.	Total Kharif.	Total Rabi.	Total Annual.	Revenue.
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Rs.
Garhi Yasin	2,103	....	288	120	....	288	120	408	764
Shikarpur	5,501	358	1,599	985	244	1,957	1,229	3,186	8,065
Jacobabad	101,056	38,448	10,674	13,516	24,257	49,122	37,773	86,895	2,41,161
Nasirabad	Unknown.	2,637	15,557	4,581	....	17,924	4,581	22,505	48,900
Total ..	....	41,443	28,118	19,202	24,501	69,291	43,703	112,994	2,98,890

Cultivable Land.

	Occupied.	Unoccupied.	Total.	
Garhi Yasin	2,103	4,142	6,245	
Shikarpur	5,501	3,509	9,010	
Jacobabad	101,056	13,224	114,280	
Nasirabad		....	190,500	(95 per cent. of 200,500).
		Grand Total ..	320,035	

Kalat Branch.

First ten years—

Gross Revenue.

I.—*Southern Perennial Area.*

					Rs. a. p.	Rs.
35,000 acres—Dry Kharif	..	9,450	acres at	..	4 0 0	37,800
Rabi	..	9,450	„ at	..	5 0 0	47,250
		18,900				85,050

II.—*Central (Kharif) Area.*

					Rs. a. p.	Rs.
950,000 acres—Rice	..	80,000	acres at	..	8 0 0	6,40,000
Dry Kharif	..	5,000	„ at	..	4 0 0	20,000
		85,000				6,60,000

III.—*Northern Perennial Area.*

					Rs. a. p.	Rs.
190,000 acres—Dry Kharif	..	50,000	acres at	..	3 0 0	1,50,000
Rabi	..	50,000	„ at	..	5 0 0	2,50,000
		100,000				4,00,000
					¾=	3,00,000

Second ten years.

I.—*Southern Perennial Area.*

					Rs. a. p.	Rs.
Dry Kharif		9,450	areas at	..	4 0 0	37,800
Rabi		10,000	„ at	..	6 0 0	60,000
Leguminous		1,500	„ at	..	3 0 0	4,500
		20,950				1,02,300

II.—*Central (Kharif) Area.*

					Rs. a. p.	Rs.
Rice		80,000	acres at	..	9 0 0	7,20,000
Dry Kharif		5,000	„ at	..	4 0 0	20,000
		85,000				7,40,000

III.—*Northern Perennial Area.*

					Rs. a. p.	Rs.
Dry Kharif		50,000	acres at	..	3 8 0	1,75,000
Rabi		57,500	„ at	..	6 0 0	3,45,000
Leguminous		7,500	„ at	..	3 0 0	22,500
		115,000				5,42,500
					¾=	4,06,875

Third ten years—

I.—*Southern Perennial Area.*

					Rs. a. p.	Rs.
Dry Kharif		9,450	acres at	..	4 8 0	42,525
Rabi		15,000	„ at	..	6 0 0	90,000
Leguminous		3,900	„ at	..	3 0 0	11,700
		28,350				1,44,225

II.—*Central (Kharif) Area.*

					Rs. a. p.	Rs.
Rice		80,000	acres at	..	10 0 0	8,00,000
Dry Kharif		10,000	„ at	..	4 8 0	45,000
		90,000				8,45,000

III.—*Northern Perennial Area.*

		Rs. a. p.	Gross Revenue. Rs.
Dry Kharif	50,000 acres at ..	3 8 0..	1,75,000
Rabi	75,000 „ at ..	6 0 0..	4,50,000
Leguminous	25,000 „ at ..	3 0 0..	75,000
	150,000		7,00,000
			¾ = 5,25,000
Gross Revenue—			
First ten years			10,45,050
Second ten years			12,49,175
Third ten years			15,14,225
Net Revenue—			
First ten years—			
Gross Revenue			10,45,000
Deduct Present Revenue			3,00,000
			7,45,000
Deduct Working Expenses—			
203,900 acres at Rs. 1·2 = Rs. 2,44,680 less 113,000 acres at Re.·96 =Rs. 1,08,480			1,36,200
	Net Revenue		6,08,800
Second ten years—			
Gross Revenue			12,49,175
Deduct Present Revenue			3,00,000
			9,49,175
Deduct Working Expenses—			
220,950 acres at Rs. 1·2 = Rs. 2,65,140 less Present Working Expenses Rs. 1,08,480			1,56,660
	Net Revenue		7,92,515
Third ten years—			
Gross Revenue			15,14,225
Deduct Present Revenue			3,00,000
			12,14,225
Deduct Working Expenses—			
268,350 acres at Rs. 1·2 = Rs. 3,22,020 less Present Working Expenses Rs. 1,08,480			2,13,540
	Net Revenue		10,00,685
I. Cost of Canal, without share of Barrage, 3,180 cusecs at Rs. 4,277 per cusec Rs.			1,32,00,860
			1,36,00,860(?)

Percentage of Return—

First ten years.	Second ten years.	Third ten years.
4·6 per cent.	6·0 per cent.	7·6 per cent.
(4·5?)	(5·8?)	(7·4?)

1,32,00,860

II. Cost of Canal *plus* $\frac{1}{19}$th share of Barrage, Rs. 1,36,00,860 (?) *plus* Rs. 22,91,666	1,54,92,526
	1,58,92,526(?)

Percentage of Return—

First ten years.	Second ten years.	Third ten years.
3·9 per cent.	5·1 per cent.	6·4 per cent.
(3·8?)	(5·0?)	(6·3?)

57. The rates provided for the Right Bank resemble those for the Left Bank except the rice and cotton rates. The cotton rate is lower here, because there is very little at present

and it wants encouragement. The rice rate is higher because rice is very far from wanting encouragement and because the soil in this area is specially suitable for high grade rice. But the highest rice rate proposed is well within the limit allowable, the local rice being not only higher priced but also more prolific than inferior kinds.

58. The rates are as follows :—

	First ten years. Rs. a. p.	Second ten years. Rs. a. p.	Third ten years. Rs. a. p.
Rice	8 0 0	9 0 0	10 0 0
Cotton	5 0 0	6 0 0	7 0 0
Other Kharif	4 0 0	4 8 0	4 8 0
Rabi (Wheat and Oil-seeds)	5 0 0	6 0 0	6 0 0
Leguminous Crops	2 8 0	3 0 0	3 0 0

59. The other kharif rate is lower than half the rice rate because Rs. 5 would be too high for millet crops, and it is not desired to penalize them.

60. The Jagir "hakkab" has been taken at half the ordinary rates both in kharif and rabi. The Chandia Chief's Jagir, which forms almost the whole, had no canal supply when it was granted. It was merely desert with some pasture land and some rain crops. Its present kharif supply is due to improvements by the British Government of canals constructed by Kalhora Government without the help of the Chandias.

61. It has been suggested by the Deputy Commissioner, Upper Sind Frontier, that the Shahdadkot Taluka should have special lower rates for the first ten years, on account of its present poverty. Probably some such concession may be advisable both there and in parts of Warah and Rato Dero. But it would be a special concession and need not be allowed for in our estimates. If it were, it would justify still higher rates in those tracts which have benefited at the expense of these.

The construction of the Larkana-Shahdadkot-Jacobabad Railway is assumed. It would have been made long ago but for the war.

62. The cost of the Right Bank Canal is so uncertain that it is perhaps hardly worth while to attempt to show percentages of profit. But assuming that construction is possible at the same rate per cusec as that taken for the Left Bank the figures (including the cost of half the Barrage) would be :—

First ten years	4·8 per cent.
Second ten years	6·1 „
Third ten years	8·2 „

63. That this very great canal can show such a profit in spite of the high existing revenue is due to the new method of fixing the discharge. The former project included a margin of 25 per cent. presumably for the overlap of kharif and rabi crops. This was entirely unnecessary, since it was not a cotton canal. Even if cotton is grown in our Northern and Southern areas to the fullest extent yet it could never possibly exceed double the rice. The overlap difficulty does not therefore arise at all.

64. Tables of Rates and statements showing cultivation Estimates and Financial Forecasts for the Right Bank are appended.

65. We have assumed for irrigated Forests the rate of Re. 1-8-0 per acre which was agreed on in 1909. The present Deputy Conservator proposes that his department should pay a special concession rate of four annas per acre for the first twenty years and a higher rate afterwards, since it will take that time for irrigation to bring in any substantial return in forest produce. This proposal seems perfectly reasonable. But we have not thought it necessary to amend our estimates accordingly, for the following reasons. First, it would be a special concession. Secondly, the amount would not be sufficient to alter the percentage on fifteen million rupees. Thirdly, it would not reduce the revenue but only postpone it to the third period. Fourthly, whether paid or remitted the money would still belong to Government.

Right Bank.

Incidence of Assessment on Zamindar's Assets (i.e., Half Net Outturn.)

Crop.	Average outturn per acre maunds.	Price.	Value.	First 10 years.		Second 10 years.		Third 10 years.		Rate at 40 per cent. Assets.
				Rate.	Incidence.	Rate.	Incidence.	Rate.	Incidence.	
		Rs. a.	Rs. a.	Rs. a.	Per cent.	Rs. a.	Per cent.	Rs. a.	Per cent.	Rs. a.
Rice, Sugdasi	25	3 0	75 0	3 0	21·5	9 0	24	10 0	26·5	15 0
Cotton	5	9 0	45 0	5 0	22	6 0	26·5	7 0	31	9 0
Other Kharif (Juar)	10	3 0	30 0	4 0	26·5	4 8	26·5	4 8	30	6 0
Rabi { Wheat	10	5 0	50 0	5 0	22·5	6 0	27	6 0	27	8 12
Rabi { Rape	7	5 8	38 8							
Gram	6	4 0	24 0	2 8	21	3 0	25	3 0	25	4 12

Right Bank.

Cultivation Forecast.

	Occupied Area.	Rice.	Cotton.	Other Kharif.	Rabi.	Dubari.	Total Kharif.	Total Rabi.	Total Annual.
Present	1,375,400	390,318	215 Intensity	190,569 Gross, 72 per cent.	190,791 Ex. Dubari 56	220,176 per cent.	581,102	410,967 Ex. Dubari. 771,893	Rs. 9,92,069
Proposed.									
First ten years	1,772,000	465,000 Intensity Gross	.... 70 per cent.	223,000 Ex. Rice 59 per	550,000 cent. Ex. Rice	.... and Leguminous	688,000 59 per cent.	550,000	12,38,000
Second ten years	1,772,000	465,000 Intensity	30,000 Gross—73·2	203,000 per cent. Ex.	600,000 Rice 63·7 per cent	.... Ex. Rice and	698,000 Leguminous 62·2	600,000 per cent.	12,98,000
Third ten years	1,772,000	465,000 Intensity	95,000 Gross—88·5	143,000 per cent. Ex.	866,000 Rice 84·5 per cent	.... Ex. Rice and	703,000 Leguminous 83	866,000 per cent.	15,69,000

Gross Revenue, Present, Rs. 28,83,768. Proposed—1st Decade—Rs. 71,90,000. 2nd—Rs. 83,74,000. 3rd—Rs. 1,04,16,500.

Right Bank.

I.—Central Area.

Cultivation and Gross Revenue.

First ten years :—			Rs.
Rice	335,000 acres at Rs.	8	26,80,000
Other Kharif	13,000 „ at Rs.	4	52,000
	348,000		27,32,000
	Deduct Jagir		5,000
	Gross Revenue		27,27,000
Second ten years :—			Rs.
Rice	335,000 acres at Rs.	9	30,15,000
Other Kharif	13,000 „ at Rs.	4	52,000
	348,000		30,67,000
	Deduct Jagir		8,000
	Gross Revenue		30,59,000
Third ten years :—			Rs.
Rice	335,000 acres at Rs.	10	33,50,000
Other Kharif	13,000 „ at Rs.	4–8	58,500
	348,000		34,08,500
	Deduct Jagir		10,000
	Gross Revenue		33,98,500

II.—Northern Area.

First ten years :—			Rs.
Rice	80,000 acres at Rs.	8	6,40,000
Other Kharif	110,000 „ at Rs.	4	4,40,000
Rabi	315,000 „ at Rs.	5	15,75,000
Do. Leguminous	10,000 „ at Rs.	2–8	25,000
	515,000		26,80,000
	Deduct Jagir		1,10,000
	Gross Revenue		25,70,000
Second ten years :—			Rs.
Rice	80,000 acres at Rs.	9	7,20,000
Other Kharif	100,000 „ at Rs.	4	4,00,000
Cotton	10,000 „ at Rs.	6	60,000
Kharif, Leguminous	10,000 „ at Rs.	3	30,000
Rabi	300,000 „ at Rs.	6	18,00,000
Do. Leguminous	50,000 „ at Rs.	3	1,50,000
	550,000		31,60,000
	Deduct Jagir		1,40,000
	Gross Revenue		30,20,000
Third ten years :—			Rs.
Rice	80,000 acres at Rs.	10	8,00,000
Cotton	55,000 „ at Rs.	7	3,85,000
Other Kharif	60,000 „ at Rs.	4–8	2,70,000
Kharif, Leguminous	10,000 „ at Rs.	3	30,000
Rabi	400,000 „ at Rs.	6	24,00,000
Do. Leguminous	100,000 „ at Rs.	3	3,00,000
	705,000		41,85,000
	Deduct Jagir		1,85,000
	Gross Revenue		40,00,000

III.—Southern Area.

First ten years :—

				Rs.
Rice	50,000	acres at Rs. 8	..	4,00,000
Other Kharif	100,000	„ at Rs. 4	..	4,00,000
Rabi	215,000	„ at Rs. 5	..	10,75,000
Do. Leguminous	10,000	„ at Rs. 2–8	..	25,000
	375,000			19,00,000
	Deduct Jagir		..	7,000
	Gross Revenue		..	18,93,000

Second ten years :—

				Rs.
Rice	50,000	acres at Rs. 9	..	4,50,000
Cotton	20,000	„ at Rs. 6	..	1,20,000
Other Kharif	70,000	„ at Rs. 4	..	2,80,000
Kharif Leguminous	10,000	„ at Rs. 3	..	30,000
Rabi	225,000	„ at Rs. 6	..	13,50,000
Do. Leguminous	25,000	„ at Rs. 3	..	75,000
	400,000			23,05,000
	Deduct Jagir		..	10,000
	Gross Revenue		..	22,95,000

Third ten years :—

				Rs.
Rice	50,000	acres at Rs. 10	..	5,00,000
Cotton	40,000	„ at Rs. 7	..	2,80,000
Other Kharif	50,000	„ at Rs. 4–8	..	2,25,000
Kharif, Leguminous	10,000	„ at Rs. 3	..	30,000
Rabi	300,000	„ at Rs. 6	..	18,00,000
Do. Leguminous	66,000	„ at Rs. 3	..	1,98,000
	516,000		..	30,33,000
	Deduct Jagir		..	15,000
	Gross Revenue		..	30,18,000

NET REVENUE—RIGHT BANK.

First ten years :—

		Rs.
Gross Revenue	..	71,90,000
Add interest on Malikano 5 per cent. on 300,000 acres at Rs. 10	..	1,50,000
		73,40,000
Add Forest Revenue, 40,000 acres at Re. 1-8.	..	60,000
		74,00,000
Deduct Present Revenue	..	28,83,760
		45,16,240

Deduct Working Expenses—

1,238,000 acres at Rs. 1·2 — 14,86,000		
less 992,000 acres at Rs. ·96 — 9,52,000	..	5,34,000
Net Revenue	..	39,82,240

		Rs.
Cost of 162,000 (16,200?) cusecs, at Rs. 4,277 per cusec	..	6,92,87,400
Add half cost of Barrage	..	1,37,50,000
Total Cost	..	8,30,37,400

Percentage of Return of Net Revenue on Cost, 4·8 per cent.

Second ten years :—

	Rs.
Gross Revenue	83,74,000
Add Interest on Malikano	1,50,000
	85,24,000
Add Forest Revenue	60,000
	85,84,000
Deduct Present Revenue	28,83,760
	57,00,240
Deduct Working Expenses—	
1,298,000 acres at Rs. 1·2—15,57,600	
less Present Working Expenses—9,52,000	6,05,600
Net Revenue ..	50,94,640

Cost plus half Barrage, Rs. 8,30,37,400.
Percentage of Return of Net Revenue on Cost, 6·1 per cent.

Third ten years :—

Gross Revenue	1,04,16,500
Add Interest on Malikano	1,50,000
	1,05,66,500
Add Forest Revenue	60,000
	1,06,26,500
Deduct Present Revenue	28,83,760
	77,42,740
Deduct Working Expenses—	
1,569,000 acres at Rs. 1·2—Rs. 18,82,800	
less Present Working Expenses—Rs. 9,52,000	9,30,800
Net Revenue ..	68,11,940

Cost plus half Barrage, Rs. 8,30,37,400.
Percentage Return of Net Revenue on Cost, 8·2 per cent.

CHAPTER V.

Eastern Nara.

66. We have orders to include in our report the prospects of revenue on the Eastern Nara system without any improvements except what result from the Barrage.

No soil survey was made in the Eastern Nara area. As no new work was contemplated and there was no question of high intensities, a regular survey would have been a waste of valuable time. But Mr. Baker is acquainted with that country, having recently prepared settlement proposals for five of the talukas and toured through the other three. The knowledge thus gained entirely confirms Mr. Lucas' experienced opinion on the soil and possibilities of this tract, and we have adopted his figures with slight modifications.

Mr. Lucas reduced the cultivable area on the Jamrao from 771,000 acres to 676,000 acres and the reduction seems excessive, since the excluded area is mostly what we call B land and such land is now cultivated in places even on the Jamrao. We have therefore added 24,000 acres to the area.

67. Our estimates of crops are the same as Mr. Lucas' except that we expect a little more rabi in accordance with recent experience.

68. In the matter of rates much has changed since Mr. Lucas wrote. Prices (and not war prices) have risen considerably. Recent settlement enquiries have shown that the rates were much lower than would be right on a Barrage canal: and the experiment of a Rs. 7 rice on the Hiral failed to check the expansion of rice.

We have therefore taken the following figures, higher than Mr. Lucas' but lower than those on the other canals. The rise is moderate considering the facts.

	First ten years.	Second ten years.	Third ten years.
	Rs. a. p.	Rs. a. p.	Rs. a. p.
Rice.	6 0 0	7 0 0	8 0 0
Cotton	5 0 0	6 0 0	6(7?) 0 0
Other Kharif	3 0 0	3 8 0	4 0 0
Rabi	4 8 0	5 0 0	6 0 0
Leguminous Crops	2 4 0	2 8 0	3 0 0

Eastern Nara.—Without Improvements.

Cultivation Forecast.

	Occupied Area.	Rice.	Cotton.	Other Kharif.	Total Kharif.	Rabi.	Total Annual.	Gross Revenue.
Present.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Rs.
(Figures of 1910)	1,198,000	132,500	150,000	102,330	384,830	164,250 Dubari 19,600	568,680 Ex. Dubari. 549,080	20,17,034
Proposed.								
First ten years	1,269,000	150,000	220,000	1,00,000	470,000	200,000	670,000	32,00,000
Second ten years	1,269,000	140,000	250,000	90,000	480,000	300,000	780,000	40,45,000
Third ten years	1,269,000	140,000	250,000	90,000	480,000	300,000	780,000	47,30,000
Present 47·4 per cent. Excluding Dubari, 45·8 per cent. ..	First 10 years. 52·7 per cent. Ex. Rice, 46·4 per cent.		*Intensity* Second 10 years, 61·4 per cent. Ex. Rice, 56·7 per cent.		Third 10 years. 61·4 per cent. Ex. Rice, 56·7 per cent.			

Discharges Required—Kharif, 8,578 cusecs. Rabi, 2,069 cusecs.

EASTERN NARA.

Without Improvements.

First ten years :—

			Rs.
Rice	150,000	acres at Rs. 6	9,00,000
Cotton	220,000	„ at „ 5	11,00,000
Other Kharif	100,000	„ at „ 3	3,00,000
Rabi	200,000	„ at „ 4-8	9,00,000
	6,70,000		
		Gross Revenue	32,00,000
		Deduct present Revenue	20,17,000
			11,83,000
Deduct Working Expenses, at Re. 1 per acre, 670,000—569,000			1,01,000
		Net Revenue	10,82,000

Second ten years :—

			Rs.
Rice	140,000	acres at Rs. 7	9,80,000
Cotton	250,000	„ at „ 6	15,00,000
Other Kharif	90,000	„ at „ 3-8	3,15,000
Rabi	200,000	„ at „ 5	10,00,000
Rabi, Leguminous	100,000	„ at „ 2-8	2,50,000
	780,000		
		Gross Revenue	40,45,000
		Deduct Present Revenue	20,17,000
			20,28,000
Deduct Working Expenses, at Re. 1 per acre, 7,80,000—5,69,000			2,11,000
		Net Revenue	18,17,000

Third ten years :—

			Rs.
Rice	140,000	acres at Rs. 8	11,20,000
Cotton	250,000	„ at „ 7	17,50,000
Other Kharif	90,000	„ at „ 4	3,60,000
Rabi	200,000	„ at „ 6	12,00,000
Rabi, Leguminous	100,000	„ at „ 3	3,00,000
	780,000		
		Gross Revenue	47,30,000
		Deduct present Revenue	20,17,000
			27,13,000
Deduct Working Expenses, at Re. 1 per acre, 780,000—569,000			2,11,000
		Net Revenue	25,02,000

69. The present revenue in this area may be taken as the same as in Mr. Lucas' time. The canals are the same and no new Settlements have been sanctioned.

70. We have calculated both present and future working expenses at the same rate of Re. 1 per acre, there being no change sufficient to increase the rate.

71. The unimproved Nara will give a good profit without expense. We have therefore no reason to press for any new works in that area. They will, no doubt, be desirable at some future time but neither money nor labour would be available for them until the Left and Right Bank Canals were finished, so they need not be considered for many years yet. It is of course necessary to leave enough water for them in the Indus, and this we have not forgotten.

CHAPTER VI.

Irrigated Forests.

72. No special provision has been made for Forests because the amount of water agreed upon at the time of the former projects was not more than the canals can carry above their designed discharge during the inundation. No rabi supply was asked for them, but we can give this also except during the "overlap" months of March and October on the Left Bank. In addition, if cultivation keeps to its normal seasons, we can turn about half the Left Bank Canal into the Forests during April and most of May, and nearly the whole of the Southern Right Bank Canal. Thus the Forests will be well provided for. But as this extra supply is only surplus water and cannot be guaranteed it does not seem necessary to raise the agreed rate of Re.1-8 per acre.

CHAPTER VII.

Analysis of Soils and Water Logging.

73. The Agricultural Chemist, Mr. Tamhane, who was deputed to assist us did not join until late in the present season when the Soil Survey was almost finished. He is engaged in researches into the nature of Kalar, which are of great general interest but do not directly affect the Projects. The question of water logging has not been forgotten. It is for this reason that we have excluded rabi irrigation from the Right Bank Central Area.

But it must be remembered that the effect of our proposals is not to increase the amount of water put on to the land. The discharge of the present inundation canals largely exceeds that of the proposed perennial ones. In the main perennial areas the subsoil water is now generally low and it is not likely that the light watering required for rabi crops, spread over a large area, will have more effect than existing kharif irrigation has had.

A regular contour survey of the subsoil water table over the Rohri Canal area has been placed on a working basis. Wells have been selected at regular intervals over this area for biennial observation of water levels. The levels so observed will be plotted and connected into a regular and comprehensive contour survey, affording a reliable and continuous record of the effect of perennial irrigation on the subsoil water table of the tract.

CHAPTER VIII.

Colonisation.

74. It is perhaps premature to discuss colonisation methods in a project report, but it may be useful to record opinions now *de bene esse*.

As stated above the colonisation problem is not to attract immigrants but to move men from one part of the area to another. A few Punjabi wheat growers can find room and will be welcome. A few men from the Upper Sind Frontier would be very useful, since some zamindars of that District of whom Bahadur Khan Khoso is the best known, are experts in economy of water and soil. But the project area itself contains plenty of skilled cultivators. The wheat growers of Larkana, Rato Dero and Naushahro sub-divisions, for instance, and the cotton growers of Hala and Shahdadpur have little to learn from any Indian.

But good cultivators, even if they own no land, are usually prosperous and unwilling to leave their homes to live in a desert as labourers or tenants-at-will. Consequently the old Sind custom of giving nearly all land to zamindars and leaving them to get cultivators was never very successful, even when the zamindars had a free hand.

The only way to get these men where they are wanted is to treat them as settlers are treated in Australia, to give them land and lend them money to build houses and start farming. There need be no fear of denuding the old villages since one man on a perennial flow canal can farm four times as much land as he could on an inundation lift canal.

The peasant colonist system has been tried in Sind, but to a very small extent with Sindhi peasants.

It is not meant that no land should be given to zamindars. Local claims must be respected if the zamindars are efficient and some are quite efficient. Both the zamindari system and the peasant proprietor system have merits and demerits. Our object should be to take the best of each.

A third method that of giving land in charity or in lieu of pension, is one which benefits neither the giver nor the recipient.

Small amounts for "malikano" have been included in the estimates, it being assumed that about half of the A lands might be sold at prices from Rs. 10 to Rs. 20. Government can certainly get that amount, so it is right to include it in accordance with precedent but it might pay better to forego it in most cases and give the zamindars a fair start.

CHAPTER IX.

Financial Results.

75. Some attempt has been made in the course of this report to forecast the financial results of the Right Bank and Left Bank Canals separately, debiting half the cost of the Barrage to each. This is, however, not really correct, since neither canal can be made without the other, and the Eastern Nara also will get its increased revenue from the Barrage and must therefore share the cost.

We therefore give below the figures of estimated total net revenue on the entire project and percentages of profit on the cost calculated as already described in previous chapters.

Capital Cost of Combined Projects.

		Rs.
Left Bank Canal	..	4,33,60,226
Right Bank Canal	..	6,92,87,400
Barrage	..	2,75,00,000
Total Cost		14,01,47,626

Anticipated Net Revenue.

	First 10 years. Rs.	Second 10 years. Rs.	Third 10 years. Rs.
Left Bank ..	32,38,460	53,73,460	78,58,460
Right Bank ..	39,82,240	50,94,640	68,11,940
Eastern Nara ..	10,82,000	18,17,000	25,02,000
Total	83,02,700	1,22,85,100	1,71,72,400

Estimated Percentage of Return on the Combined Projects.

First 10 years.	Second 10 years.	Third 10 years.
5·92 per cent.	8·76 per cent.	12·25 per cent.

These percentages are of course premature, since the cost of the canals as finally designed is not yet known. But they do at least show that the project has a good prospect of being a productive work from the beginning.

Profits on the Punjab scale could not of course be expected. We have a developed irrigated country to deal with, not a desert like the Punjab Bars and Thals. At first sight it seemed almost hopeless to make such great works profitable when we had to surpass a present revenue of forty five lakhs before we could show any return whatever. But we hope that this report shows that we have succeeded.

Even if the final estimates of cost are so high as to make the project unremunerative, even after ten years, we are prepared to show that it is necessary as a protective work. But to anticipate such an improbable event is unnecessary.

C. M. Baker,
Collector on Special Duty.

C. M. Lane,
Executive Engineer on Special Duty.

COPY OF THE MINUTES OF THE IRRIGATION CONFERENCE HELD ON 19TH JANUARY 1918.

Present.

The Honourable Mr. H. S. Lawrence, I.C.S., Commissioner in Sind.

Mr. T. R. J. Ward, C.I.E., M.V.O., M.I.C.E., Inspector General of Irrigation in India.

Mr. F. St. J. Gebbie, Chief Engineer and Secretary to the Government of Bombay, P.W.D.

Mr. F. Wright, Chief Engineer, Sind, P.W.D.

Mr. C. M. Baker, I.C.S., Collector on Special Duty.

Mr. G. S. Henderson, Imperial Agriculturist.

Mr. W. Roberts, Principal and Professor of Agriculture, Lyallpur.

Mr. C. M. Lane, Executive Engineer on Special Duty.

The Commissioner opened the proceedings by stating that the object of the conference was to discuss what Mr. Baker and Mr. Lane should do. He asked Mr. Ward what Mr. Lane had seen in the Punjab.

Mr. Ward replied that Mr. Lane had been shown a Colony at Sargodha, the canal at Rasul and the latest up-to-date watercourses and the head-works of the Mangala canal. Then he had been shown the Farm at Lyallpur and the work of sub-soil investigation, the modelling of works and also he had discussed with the Agricultural Chemists the mathematical and physical effects of water on soil. He added that this was only understood empirically at present and it was not yet possible at present to offer any generalisations.

The Commissioner asked Mr. Gebbie if the Bombay Government intended to issue special instructions for the guidance of Mr. Baker and Mr. Lane.

Mr. Gebbie replied that orders were being issued. Mr. Baker's programme of work had been shown to Mr. Ward, who had agreed to it and it had been accepted by Government.

Preparation of revenue estimates.—Mr. Ward, referring to Mr. Baker's memorandum, stated that the first point put down there was the enquiry what lands were cultivable, what crops could be grown on them, and where they could be grown. Mr. Ward proceeded to point out that the difficulty in preparing a revenue estimate in Sind on irrigational projects would lie in showing the increase of revenue that could be expected from the scheme over that which was already being obtained. He pointed out that at this stage the estimates framed by engineers would not be finished to the last detail but only so far as would be necessary to inform the Revenue authorities what the cost of any scheme would be.

Duty of water.—The Commissioner supposed that Mr. Baker and Mr. Lane would have to work up to a definite proposal of the size the canal scheme would have to take.

Mr. Ward replied that this led up to the second point of the duty of water. He added that he was in favour of a barrage and was of opinion that the barrage should not be put off. It would be more difficult to make it a paying project as the development of cultivation under present conditions progressed. For, then the difference between the revenue to be obtained after the project was completed and the revenue before the project, would be less than if the work were taken in hand soon. Government on any scheme required direct returns in the same way that a business firm required them, and, if the barrage scheme were much delayed, it might be necessary to resort to the purchase of land commanded by the proposed canal and its resale at enhanced prices in view of the benefits conferred by the canal. This would necessitate legislation and entail much opposition, which it was desirable to avoid if possible.

He stated that the duty must also be considered from the point of view of water-logging. It was not possible, however, for him to give an opinion on this question. This must be left to people who knew Sind conditions.

Mr. Gebbie stated that rainfall would have to be ignored in Sind.

The Commissioner presumed that when the duty was settled, it would be necessary to work up to the cusecs the canal must carry, and, in this connection, added that another factor to be considered was the amount of land that should be cultivated each year upon the canal.

Mr. Ward replied that the Punjab authorities now felt that there was no objection to full cultivation of land each year if that were possible agriculturally but he believed that it was not possible to cultivate 100 per cent. since experience showed that the land soon lost its productiveness.

The Commissioner said he understood that in the Punjab canals by their system of control they were able to allocate the exact number of cusecs necessary for each karia, and he thought that in Sind they were a long way yet from that position.

Mr. Gebbie was of opinion that the control on the Jamrao was as good on the whole as on the Punjab canals.

Mr. Ward stated that with inundation canals it was necessary to have more liberal outlets than with perennial canals, because the period of supply of water was shorter in the former case

than in the latter, and it was necessary to get water out over the land more quickly. He pointed out that in his opinion there was no danger of shortage of rabi water for the canal. The lowest cold weather supply of the river on record was 16,000 cusecs, and they had found in the Punjab that an average of 7,000 cusecs was sufficient to command an area of one and a half million acres of rabi.

Rates.—The Commissioner asked Mr. Gebbie if the Irrigational authorities would have any objections to the cultivation of rice.

Mr. Gebbie replied that there was no objection to its cultivation if it paid three times the cotton assessment.

Mr. Roberts remarked that the water and land rates combined on the Chenab canal came to Rs. 9 an acre.

Mr. Lane said that the charge for water alone on the Upper Jhelum canal was Rs. 7-8 an acre, and on the lower Jhelum canal Rs. 10 an acre.

Mr. Ward added that in addition to these water-rates there was an additional land assessment of Rs. 7 an acre.

Mr. Gebbie said that it was quite obvious that in Sind the rates must be wholly revised, otherwise the Government of India would probably not approve of the scheme.

Mr. Ward here interjected that the water-rates in the Punjab were really based on the value of the crop and not on the water taken for any crop. The land revenue was laid down as equal to half the net assets but when water-rate and land revenue were commuted into cash, and this was done over a wide area in which the quality of lands differed considerably, it was necessary to pitch your rates low to avoid hardship on the poorer tracts.

Mr. Gebbie pointed out that settlements in Sind were revised for comparatively small tracts, not large ones.

Mr. Lane stated that in the Punjab it was the water-rate that was fixed while the land rate varied.

Mr. Ward replied that this was because the engineers argued that they were able to supply the same amount of water for different kinds of land ; therefore, their water-rates must be the same and that any difference due to difference in the quality of the soil must be shown in the difference of land assessment.

Mr. Lane drew attention to the fact that in the project which had been previously put up it had been calculated that the average return per acre for the first ten years would be Rs. 4·35 per acre, and finally Rs. 5·05 per acre. This was for the Left Bank scheme.

Mr. Gebbie was of opinion that the Sindhi could certainly pay much higher rates than he is now paying in view of what the Punjabi pays, because in selling the produce he was saved the freight from Lyallpur to, say, Shahdadpur, the northernmost point in Sind affected by the new canal.

Methods of cultivation.—Mr. Henderson stated that this went on the assumption that the cultivation would be as good as that of the Punjab and he doubted whether this was the case.

Mr. Baker gave the opinion that the Sindhi grew better cotton that the Punjabi colonists on the Jamrao.

The Commissioner stated that he thought that the Sindhi was rising to the level of the Punjabi.

Mr. Henderson, however, was doubtful on this point.

Mr. Gebbie stated that his experience was that the improvement in cultivation on the Jamrao was exceedingly disappointing. He was of opinion that the Sindhi needed much more instruction and many more demonstration farms and plots needed to be established throughout the country.

Mr. Baker rather deprecated the criticisms of the Sindhi cultivator for in Upper Sind the wheat lands were ploughed repeatedly and kept clean.

Mr. Gebbie replied this was however due to the fact that wheat in Upper Sind was cultivated on bosi and water had to be conserved from the kharif season. He reiterated his view that more demonstration farms and plots were necessary.

Demonstration farms.—The Commissioner asked if it would not be possible to have these demonstration farms before the canal was made. He pointed out the necessity for a wheat farm on the Eastern Nara Supply Channel.

Mr. Henderson agreed but stated one difficulty lay in the want of staff. He asked if the possibility could be considered of training agricultural students at Lyallpur in preference to Poona. He pointed out the training of Poona was for Presidency conditions which were totally different to those in Sind, while the training at Lyallpur which suited Punjab conditions would suit Sind.

Mr. Roberts said that they would be glad to train Sindhi students at Lyallpur.

The Commissioner asked how many could be taken at Lyallpur.

Mr. Roberts stated he thought that 8 to 10 could be taken annually for the four years' course. There was also a two years' course.

Mr. Ward here pointed out that in the Punjab it had been difficult to get students for the College until good appointments could be promised.

The Commissioner asked Mr. Henderson what his opinion was of the desirability of opening demonstration farms at once.

Mr. Henderson replied that he thought this would be a good course and suggested that one each in the northern, central and southern portions of the tract to be commanded by the canal should be in readiness before the opening of the canals.

Intensity of cultivation.—Mr. Roberts urged the necessity of such demonstration farms on the ground that the intensity of cultivation must be pushed, *e.g.*, berseem ; which he understood was becoming popular in Sind should be more widespread.

Mr. Henderson agreed that this was necessary as wheat repeated on the same land soon deteriorated it. He added however that the seed for berseem was not at present available.

The Commissioner asked whether the greater heat of Sind would not cause quicker evaporation than the Punjab.

Mr. Gebbie replied that Mr. Howard did not believe so and argued that moisture could be conserved in the soil, but he understood that Mr. Henderson totally disagreed with Mr. Howard.

The Commissioner asked that if the evaporation were quicker in Sind than in the Punjab, whether this would not mean a greater supply of water in the canal.

Mr. Gebbie said this would be necessary in any case inasmuch as rain would have to be neglected for Sind.

Mr. Ward however was of opinion that a more important factor than rain was soil and he asked if it was not true that less water meant more labour.

Mr. Roberts said that was undoubtedly so.

Scheme of canal.—The Commissioner asked what data were available to assist Mr. Baker and Mr. Lane in deciding whether the canal was to run full or on a rotational scheme.

Mr. Ward stated that their experience in the Punjab had left this question unsolved. He was of opinion that the canal must be devised for the kharif supply which meant that it would be too large for the rabi in which season it would have to be closed down.

Mr. Baker asked if it would not be possible to construct the canal in two parallel channels, both being used in the kharif season and only one in the rabi.

Mr. Ward replied that they had considered that scheme among many others in the Punjab by academic enquiry and they had now come to the conclusion that they must trust to rotation to cut down the supply. Into this question of rotation he was enquiring at present with Mr. Roberts.

The Commissioner asked Mr. Lane if he had any questions to raise.

Mr. Lane replied that he did not think there should be much difficulty about duties. They had already obtained useful details for duties on inundation canals. He was of opinion that they could work out the duties for perennial canals by multiplying those they had obtained by the necessary coefficient. He had found by experience that 30 was the correct duty for rice and 65 for cotton. In his opinion the important question was to fix the intensity of cultivation.

Mr. Ward replied that the intensity in the Punjab was fixed very low with the result that more water was given for the land actually cultivated.

Mr. Lane drew attention to the fact that Dr. Summers in his scheme had put the intensity of cultivation at 50 per cent.

Mr. Henderson replied that this was correct but only so far as the canal might work up to in 10 years under existing circumstances.

Mr. Lane stated that he supposed then that Mr. Baker and he would first have to engage in soil classification. Under the circumstances he thought that Mr. Baker should at once go to the Punjab. From what he had seen his views had changed considerably. He had seen land in the Punjab which in Sind would certainly be classed as fit for rice only yet was bearing good cotton crops.

Mr. Henderson stated that he was of opinion that it would be a mistake to postulate intensity at only 50 per cent., for, to devise a canal on this estimate would prevent improvement in cultivation and a more intensive use of the land.

Mr. Baker stated that if the intensity was 50 per cent. for kharif there would always be water available for a far greater percentage in rabi.

COPY OF THE MINUTES OF THE IRRIGATION CONFERENCE HELD ON 20TH JANUARY 1918.

Present.

The Hon'ble Mr. H. S. Lawrence, I.C.S., Commissioner in Sind.

Mr. G. S. Henderson, Imperial Agriculturist.

Mr. W. Roberts, Principal and Professor of Agriculture, Lyallpur.

Mr. Roberts handed in a note which he had prepared "Agricultural work in connection with the Rohri-Hyderabad canal scheme."

Mr. Henderson and Mr. Roberts both stated that it was necessary to fix the intensity of cultivation on the new canal at much higher than 50 per cent.

Mr. Roberts said that he would urge 80 per cent. or even 100 per cent. and Mr. Henderson agreed.

Mr. Henderson replied that undoubtedly 100 per cent. would be preferable if the enquiry into the local conditions which was to be made would justify it.

The Commissioner asked how should the 100 per cent. be divided intc kharif and rabi.

Mr. Henderson replied in the proportion of 1 : 1 if cotton was to be specialised.

The Commissioner pointed out that this would mean rotations of closing of the canal in rabi.

After some discussion the Commissioner asked Mr. Henderson whether they insisted on the proportion of one-third kharif to two-thirds rabi.

They replied no, since the great demand was for cotton.

The Commissioner referred to the predictions pointed out of water-logging if so much water went down the canal in rabi.

Mr. Henderson did not regard this as serious as he thought the water would be taken up by fodder crops.

Mr. Roberts however said that at first a severe system of rotations and closing down of the canal would be necessary till the cultivation of fodder was properly taken up by the cultivator.

With regard to the second point in the memorandum, the Commissioner said he agreed with their proposals for the establishment of demonstration farms at once. He asked however where Mr. Henderson would suggest that the middle farm should be placed.

Mr. Henderson stated somewhere near Sakrand.

There was some further discussion and it was held that these farms must be established at once for the instruction of the cultivator and by means of pumping installations from canals and dhands to produce the conditions that would prevail with a perennial canal scheme.

On the third point, reorganisation of the Agricultural Department in Sind, Mr. Henderson stated that a Director of Agriculture in Sind was an absolute necessity and that he would require two Deputy Directors.

The Commissioner asked what work he proposed to allot to the Deputy Directors.

Mr. Henderson replied that they would have to enquire into questions of cotton and wheat cultivation, systems of rotation, and the breeding of cattle.

Mr. Roberts pointed out that the moment intensity of cultivation was pushed, the cattle question arose. More cattle would be necessary, more would be attracted to the irrigated areas, and for this increase of cattle an increase in the area under fodder crops was absolutely essential.

COPY OF THE MINUTES OF THE IRRIGATION CONFERENCE HELD ON 30TH NOVEMBER 1918.

Present.

The Honourable Mr. H. S. Lawrence, C.S.I., I.C.S., Commissioner in Sind.
T. R. J. Ward, Esq., C.I.E., M.V.O., Inspector-General of Irrigation.
F. St. J. Gebbie, Esq., Secretary to the Government of Bombay, Public Works Department.
F. Wright, Esq., Chief Engineer in Sind, Public Works Department.
C. M. Baker, Esq., I.C.S., Collector on Special Duty.
G. S. Henderson, Esq., Agricultural Controller.
C. M. Lane, Esq., Executive Engineer on Special Duty.
A. A. Musto, Esq., Executive Engineer, Sukkur Barrage.

The Commissioner recalled that a meeting had been held on January the 19th last, and the work that Mr. Baker and Mr. Lane had to do was discussed. It was suggested that the best course would be now to ask Mr. Baker and Mr. Lane at what stage they had arrived, and whether they wished to have any further instructions.

Mr. Baker stated that their report contained their views. The report submitted by Messrs. Baker and Lane, dated the 17th May, was taken as read.

Duties and intensity.—The Commissioner asked Mr. Ward and Mr. Gebbie if they considered the size of the canal as shown in that report, namely, 9,000 cusecs, to be the proper size.

Mr. Ward replied that the size of the canal depended on the duties and intensities that were adopted. The size would then increase or decrease according to the area to be commanded.

The Commissioner asked Mr. Gebbie if he was prepared to accept the proposals of Mr. Baker and Mr. Lane for duties and intensities.

Mr. Gebbie replied that he understood they were compared with those of the Lower Chenab. He was prepared to accept them, and pointed out they had already been approved by Government in Government Order No. W.—I-8601, dated 30th August 1918. Public Works Department.

Mr. Lane at this stage pointed out that the size of the canal had been calculated on the kharif duty only.

Mr. Ward enquired if any allowance of 15 per cent. for "overlap" had been allowed, as was the custom on the Punjab canals.

Mr. Lane pointed out from his figures that estimated requirements for each month in the year had been taken out and the maximum required discharge thus arrived at.

The Commissioner asked what was the area commanded by the Left Bank Canal.

In discussion it was pointed out that the culturable commanded area was 22½ lakhs of acres. The area to be irrigated by the project was 6 lakhs kharif and 12 lakhs rabi; total 18 lakhs acres. Dr. Summers' figure was 3,080,000. It was however pointed out that this was an estimate and not based on accurate enquiry.

The Commissioner asked Mr. Baker if he was able to make any statement as a result of his enquiries into soil classification. Would the culturable commanded area be increased or decreased to any considerable extent?

Mr. Baker replied that at present he was not in a position to give exact figures; but, from the results of enquiry in 8 talukas, he had found that there were 300,000 acres more of culturable land than Mr. Lucas had accepted, and he anticipated there would be proportionate results in other 4 talukas.

The Commissioner pointed out that this would add about one-fifth to the size of the canal raising the discharge to about 11,000 cusecs. He stated that Mr. Henderson in his note which had been circulated to the members of the conference had suggested an intensity of 75 on a duty of 60. The size of the canal on these figures would be approximately the same as by the proposals of Mr. Baker and Mr. Lane.

Mr. Ward calculated that taking Mr. Henderson's proposals the irrigation would amount to 1,680,000 acres and if the proportion was adopted of one-third kharif to two-thirds rabi, 9,333 cusecs would be necessary as against 8,960 of Mr. Baker and Mr. Lane.

Culturable.	Acres.
Present culturable commanded	2,250,000
Add—	300,000
	2,550,000
Kharif at 27 per cent.	688,500
Discharge at 66 acres a cusec	10,200 cusecs.

300,000 is about 1/7th of 2,250,000 and 1/7th of 9,000 cusecs is 1,290 so that 10,200 or 10,300 seems nearer than 11,000.

The Commissioner wished to know if Mr. Baker considered their present tests of culturable and unculturable land as fairly accurate.

Mr. Baker and Mr. Lane were of opinion that the present classification was sufficiently safe to work on. The classifiers were not always very experienced or very reliable. In some cases culturable land might be classed as unculturable; but they did not think there was any likelihood of an unexpectedly large demand for water by reason of any extra large area being found culturable.

The Commissioner then asked if the conference was prepared to accept 11,000 cusecs as a sufficient discharge for the canal. He pointed that this meant a considerable reduction from the discharge of 14,000 cusecs proposed by Dr. Summers.

Mr. Baker pointed out that Dr. Summers had put on a 25 per cent. margin.

Mr. Ward replied that this under the circumstances of the time was necessary as a safeguard. He however drew attention to the last paragraph in his first note of the 22nd March 1917. He had stated that Dr. Summers' canal was unnecessarily large and unduly expensive and had given reasons to reduce it to 10,000 cusecs. There would, however, probably be some opposition

to and criticism of this proposal to reduce the size of the canal to 11,000 cusecs, and he was of opinion that if this was accepted, the reasons for reduction should be very cogently and convincingly stated in the report.

It was suggested that the conference should be definitely accept the duties and intensities proposed by Mr. Baker and Mr. Lane.

Mr. Gebbie said that he accepted them subject to any remarks by Mr. Ward.

Mr. Ward was shown Messrs. Baker and Lane's report referred to above; the note struck him as very closely reasoned and though brief was complete except in the one point about wheat, on which he was informed by the Commissioner that Mr. Baker had reported since more in detail. Mr. Ward noticed that a kharif area of 600,000 acres from a canal of 9,000 cusecs maximum discharge gave a full supply factor (called by the Deccan engineers maximum discharge duty) of 66 acres a cusec at canal head against 70 the similar factor on the Lower Chenab canal. It would therefore seem that Messrs. Baker and Lane's carefully reasoned method of arriving at the maximum capacity of the canal would give a canal larger than the Lower Chenab for the same kharif irrigated area in the ratio of 70 to 66 or 6 per cent. Such a canal will stimulate the cultivation of rabi that is very necessary to insure a productive public work; if it is found that the size is too restricted and is adverse to cotton the extra volume required can be got by increasing the depth. The volume of the Lower Chenab canal has been increased from 8,313 as designed to 10,730 cusecs that now authorized, merely by increased attention to the maintenance of the banks.

As a general result of the discussion, the proposals of Mr. Baker and Mr. Lane for duties and intensities were accepted subject to any further remarks that Mr. Ward might have to make on further examination of the proposals.

Right Bank Canal.—The Commissioner asked what was to be the method of construction and of calculation for the Right Bank canal.

Mr. Gebbie pointed out that the Right Bank canal was being dealt with in quite a different manner from the Left Bank canal. The proposals for the Right Bank canal were merely, in the first instance, to provide sufficient water for the rice lands; and to effect this, it was proposed to give a new feeder to the Ghar and Western Nara canals and to construct two branches, the Shahdadpur and the Ratodero.

Both Mr. Baker and Mr. Lane showed that the effect of such proposals would be to exclude from the benefits of the scheme a great deal of the rabi land that lay towards the southern end.

Mr. Gebbie said that the Right Bank canal stopped when it got to the Western Nara at the present stage. Further developments on the Right Bank would take place as they were wanted.

In some discussion that took place it was pointed out that the present limits of the canal were not altogether reliable; that a sufficient enquiry on the spot had not been gone into; Mr. Musto had various proposals to make which Mr. Gebbie intended to examine; and it was agreed that after such an examination, Mr. Gebbie should indicate to Mr. Baker as clearly as possible the boundary of the land that would be commanded by the Right Bank scheme to enable the latter to proceed with his examination of the soil.

Mr. Gebbie and Mr. Ward both agreed that if the barrage was built and no change was made in the canals on the Right Bank, the Western Nara and the Ghar canals would be seriously damaged. These canals must be given a reliable supply, and a new feeder, as was suggested, to take off above the barrage was a necessity.

It was very generally agreed that experience of this year would convince the zamindars of the necessity of the barrage, and make them willing to pay a greater assessment to be assured of a more reliable supply of water.

Extension of rabi cultivation.—The Commissioner asked whether any members of the conference had any views on the probability of the extension of rabi cultivation. He read out Mr. Baker's report in which Mr. Baker had stated that conditions had altered since Mr. Lucas' time, and that facts were available to support an opposite view to that of Mr. Lucas that the cultivator of middle and lower Sind would not take to rabi cultivation. He had found, this year, wheat cultivation in middle and lower Sind where, previously, it had been argued that wheat could not be grown, and he stated his view that wheat would be grown if it were possible that the supply of water were assured.

Mr. Gebbie stated that this had always been his view, and that his experience of the Jamrao fully supported it. But this was still more borne out by the experience of the Fuleli where Mr. Lowsley, under his instructions, had made a supply available by means of regulators for rabi, with the result that the area under wheat had grown from a negligible quantity to 11,000 acres. But he must insist that before the zamindar could be expected to go in for rabi, cultivation over any large area, he must be assured of a constant rabi supply. Rabi cultivation on the Jamrao had been progressing very satisfactorily until the set-backs of 1907 and 1916. Given an assured supply, he was convinced that rabi cultivation would be popular.

Omission of certain tail areas from the Left Bank canal scheme.—The conference accepted the views of Mr. Baker and Mr. Gebbie. The Commissioner pointed out to Mr. Gebbie that Mr. Baker and Mr. Lane proposed to cut out from the Left Bank scheme certain tail areas in Guni, Tando Bago and Matli talukas. In Government Order No. W. I.—8601 of 30th August 1918, Public Works Department, no orders on this particular point had been issued.

Mr. Baker in support of their joint report stated that this was in reality a rice area.

Mr. Gebbie said the matter had been overlooked. He agreed that water was available from the Fuleli canal and would be available from the Eastern Nara canal scheme for these areas, and he said that the proposal in the old project to carry the water by a siphon under the Fuleli for the areas under discussion had been discarded. He would see that orders were issued approving of the proposals of Messrs. Baker and Lane.

Reorganization of the Agricultural Department in Sind.—The Commissioner raised the question of demonstration farms, and asked whether the conference supported the proposals which had been put forward by Mr. Henderson and Mr. Roberts in a meeting they had with him on the 20th of January 1918, the minutes of which meeting had been circulated to the members of the conference.

Mr. Henderson stated that the Cotton Committee would recommend three demonstration farms, and a reorganisation of the Agricultural Department in Sind under a separate Director with 2 Deputy Directors and an Economic Botanist.

The Commissioner wished to know if men were available. He had made some enquiries on the point and was informed that none were forthcoming.

Mr. Ward and Mr. Henderson stated that they had come across many instances of men who having had agricultural experience were now out in the Army in India and would be glad to accept posts in the Agricultural Department. Mr. Ward was of opinion that the matter should be taken up and a definite scheme for the reorganisation of the Agricultural Department and for demonstration farms should be worked out and sent up to Government. He thought that an Economic Botanist was very necessary and he suggested that the Agricultural School should be opened at once, and should not be postponed until a proper building was put up.

The conference agreed that the recommendations of the Cotton Committee as stated by Mr. Henderson should be adopted, and was also of the opinion that an Agricultural School was necessary.

Copy of the Minutes of the Irrigation Conference held at Government House, Karachi, on 3rd February 1919.

Present :

The Hon'ble Mr. H. S. Lawrence, C.S.I., I.C.S., Commissioner in Sind.

F. St. J. Gebbie, Esq., Secretary to the Government of Bombay, Public Works Department.

F. Wright, Esq., Chief Engineer in Sind, Public Works Department.

C. M. Baker, Esq., I.C.S., Collector on Special Duty.

C. M. Lane, Esq., Executive Engineer on Special Duty.

A. A. Musto, Esq., Executive Engineer, Sukkur Barrage.

T. F. Main, Esq., Deputy Director of Agriculture, Sind.

V. A. Tamhane, Esq., Agricultural Chemist.

The conference was called to discuss certain points raised by Mr. Main and Mr. Musto which the Commissioner thought should be considered and disposed of before the scheme left the local experts in Sind. The conference first discussed Mr. Main's proposals.

2. Mr. Main thought that the Left Bank canal should concentrate on cotton cultivation with an intensity of 50 per cent. From an irrigation point of view this would be sound, because cotton could take water for 10 months with profit. Water would be wanted for half the area on the canal at 1 cusec per 100 acres, *i.e.*, 12,500 cusecs would be required for the whole area of 2,500,000 acres on the canal, reckoning an intensity of 50.

Mr. Lane pointed out that Mr. Main's figure of 100 was an Outlet Duty and his canal Head Discharge would be increased to 17,500 cusecs after allowing for intermediate canal losses.

3. Mr. Gebbie raises two points—

(*a*) danger of water-logging;

(*b*) impossibility of providing more water than the average minimum discharge of the Indus. It is agreed that the minimum discharge during the last 20 years has been about 18,500 cusecs, and that the average monthly minimum discharge may be taken as about

22,000 cusecs, the whole of which would be taken into the canal. This has to supply the Left Bank, Right Bank and the Nara system as under, according to Mr. Lane's estimates :—

Right Bank		5,000 cusecs	(Provisional).
Left Bank		10,140 ,,	
Eastern Nara Jamrao ..	3,200 cusecs.		
Mithrao	2,000 ,,		
Khipro	1,000 ,,		
Thar	500 ,,		
Hiral	230 ,,		
Heran and distributaries ..	400 ,,	7,330 ,,	Dr. Summers' Estimate.
		22,470 cusecs.	

4. Mr. Main points out that this minimum discharge would be sufficient for his proposed canal. The minimum discharge was during February and March, and sowings could be regulated according to the time the river rose. He thought about one-fifth of the cotton area would be put under berseem, in the autumn, and would require water up to the end of April. The other four-fifths could be put under cotton any time water was available from February to April. His idea was to grow only cotton and berseem, with a very little wheat for which the berseem would serve as manure.

5. Mr. Baker pointed out that although he had only allowed for 400,000 acres of cotton, yet if people preferred to grow cotton they could grow up to 736,000 acres on the supply proposed in his scheme.

6. Mr. Main stated that whereas Mr. Baker's scheme allowed for a 27 per cent. kharif crop he wanted a 50 per cent. kharif. The fault of Mr. Baker's scheme was that it would turn the tract into a rabi tract, whereas Mr. Main thought it should be a kharif tract. The drawbacks of growing two-thirds rabi and one-third kharif were (*a*) there would be a lower standard of prosperity among the people, (*b*) less would be got out of the soil than it was capable of giving without damage to the soil. He was not prepared to say Mr. Baker's scheme was agriculturally unsound. He did not question that it was practicable and he thought it was sound. It was nevertheless true that wheat cultivation would exhaust the soil in Sind quicker than any other crop except juari. Irrigated wheat in constant succession might ruin the fertility of the soil in ten years, and would be a heavy tax on fertility even if aided by rotations with pulses and other nitrogenous crops.

7. Mr. Baker thought it extremely improbable that the people of Sind would consent to grow so much cotton without any food crop. At present there was practically no long staple cotton and no berseem being grown, and it was most unlikely that either would be grown to the extent hoped by Mr. Main within ten years of opening of the canal. Mr. Main mentioned the case of Khandesh were wide tracts of cotton were grown without food crops.

8. To a query by Mr. Lane, Mr. Main admitted that he knew of nowhere in the world where cotton was actually watered with advantage for 12 months in the year. In this connection Mr. Baker pointed out that frost in November was common in Sind : frost killed off the cotton and it was no use providing for water for cotton after that date. Mr. Main says that early frost does not knock the cotton out in the Punjab, and he thought with better irrigation cotton would stand the frost. Mr. Gebbie stated he has seen cotton crops in Sind withered by frost in December, and Mr. Baker's experience is that well watered plants stand frost even less than unirrigated.

9. The general opinion is opposed to Mr. Main's suggestion of an all cotton canal, and Mr. Main did not wish to press it. He agreed that the Baker-Lane scheme was quite a feasible one. Mr. Baker objected to Mr. Main's scheme because people would never carry it out unless the price of cotton remained relatively very high.

10. The financial aspect of the scheme was then considered. Mr. Main thought his proposal would bring in an all over Rs. 4 per acre of the total area on the canal, reckoning a 50 per cent. cotton intensity *plus* some berseem and wheat. The rates would be cotton Rs. 60, berseem Rs. 3 and wheat Rs 4. This would mean a total income of 100 lakhs on 25 lakhs of acres commanded. The deduction of the working expenses and current revenue would reduce this sum by 30 lakhs. Mr. Musto at a rough estimate thought Mr. Main's canal would cost 10 crores. The net income of 70 lakhs therefore meant a return of 7 per cent. on outlay.

11. Against this, the Baker-Lane scheme would bring an income of 116 lakhs after 30 years on an outlay of roughly 6 crores, and the deduction for current revenue and working expenses would be 36 lakhs. The net profit would be 80 lakhs or 13 per cent.

12. Mr. Baker points out that Mr. Main's scheme is bound to be less profitable because the duty for wheat is half that for cotton. Mr. Main admits this.

13. Mr. Gebbie points out that it would be necessary to go into the question of whether Mr. Main's profit of 7 per cent. would be sufficient to pay off all the arrears of accumulated interest within ten years. He agreed, too, with Mr. Baker that there was no chance of cotton

cultivation increasing within ten years to the extent Mr. Main counted on: in the early years it would be much less.

14. The Commissioner raised the point that the danger to cotton from boll worm might be much greater if the crop were perennial: and this was admitted by Mr. Main.

15. As regards quantity of water available, Mr. Wright stated that a minimum of 36,000 cusecs was available from April to December. This would be quite sufficient for Mr. Main, whose scheme was not negatived merely by the fact of deficiency in February and March.

16. *Rabi Duty.*—Mr. Main questions a rabi duty of 200, and would prefer one of 165. The required duty depends on the season, and he would be prepared to accept a higher duty if water were available early, say September.

17. Mr. Main next criticised the *overlap* of 6¼ per cent. between kharif and rabi. He thought this inadequate. If the canal were to be a cotton one the overlap should strictly be 100 per cent. Mr. Gebbie thought this would make the canal impossible from a constructional point of view.

18. Mr. Main stated that irrigating cotton from 15th October to 15th December would make a difference in outturn of 3 maunds raising it from 10 to 13 maunds. Late watered cotton would give 7 pickings, 3 of them after 15th October, the latter pickings falling off somewhat in quality especially in damp seasons. Mr. Baker pointed out that for an extra 3 maunds of cotton, an extra 2 acres of wheat which would produce 10 maunds per acre were being sacrificed. He was not prepared to increase the overlap. The 13 per cent. was only a rough estimate of profit on his scheme: only 9·5 per cent. was guaranteed. He undertook to discuss this question of overlap fully in his report.

19. Mr. Gebbie pointed out the much greater financial risk of Mr. Main's proposals. His proposal was a big scheme incapable of contraction. Mr. Baker's was a smaller one but capable of expansion. Mr. Main points out that he has no positive objection to the Baker-Lane scheme, but would prefer his own. The general opinion was obvious that the Baker-Lane scheme should be proceeded with, and he was content to leave it at that.

20. *Right Bank Canal.*—The *duty on rice* was discussed. Mr. Main wanted a duty of 40 instead of 50 and thought rice could pay the necessary extra assessment to make it productive. Mr. Gebbie, in reply to the Commissioner, thought no guidance could be got from the Punjab, where rice was only grown in small patches. Mr. Lane suggested a trueer indication could be got from the lift rice which was grown in Thar-Parker: water here could not be wasted. The general opinon was that in the absence of more precise data for Mr. Main's demand, the proposed duty should stand.

21. The conference then proceeded to discuss a suggestion of Mr. Musto's regarding the Right Bank Canal. He thought an extra 400,000 acres of land, half in Nasirabad and half in British territory could be brought under command. It was decided that this scheme might be held in abeyance meantime, and the Government of India might be informed when the scheme was sent up that there was a possibility of the land being taken up in future.

22. In the meantime Messrs. Baker and Lane should send in their report on the Left Bank and Eastern Nara scheme and a separate report about the Right Bank scheme within the course of the next six weeks or so.

APPENDIX I.

Amplification by Mr. Main of some points raised at the Karachi conference held on 3rd February 1919.

I.

Vide my remark that a high wheat intensity might ruin the fertility of the soil in 10 years. Experience gained in an experiment on the Mirpurkhas Farm has been as follows.

Plot B 7 on the Mirpurkhas experimental farm consists of first class soil being sweet and having a free working texture. In the two previous years to 1908-09 it had been cropped with bajri and cotton respectively. Subsequently to this it was put under permanent irrigated wheat, *i.e.*, wheat every rabi season and the plot received good tillage in the kharif seasons. The results are tabulated below:—

Name of the year.	Yield of grain in lb. per acre.	Number of irrigations.	Remarks.
1908-09	480	1	Low yield due apparently to insufficient water.
1909-10	1,040	5	
1910-11	710	3	
1911-12	429*	3	
1912-13	358	4	
1913-14	316	4	

* In this season the variety of wheat was not of Sind. In 1913-14 Mr. Henderson recorded the opinion that the land was now exhausted and that berseem would be taken in 1914-15 before continuing the experiment.

Accordingly two crops of berseem were taken in 1914-15 and 1915-16 and then wheat was resumed with the following results:—

Name of year.	Yield of grain in lbs. per acre.	Number of irrigations.	Remarks.
1916-17	170	2	Sunn hemp ploughed in as green manure in kharif season.
1917-18	460	2	

In my opinion these results indicate that irrigated wheat will exhaust an average Sind soil in 4 or 5 years even when the yields are very moderate and this observation is in accordance with general observations on other plots which have been cropped with wheat.

II.

Vide Mr. Baker's point that an extra 23 maunds of cotton per acre gained at the expense of rabi water which otherwise would produce 20 maunds of wheat from 2 acres of land would not compensate the cultivator.

This conclusion is more apparent than real and derives its force from isolating a part from the whole of the cultivator's produce. Below I give what appears to me to be the true comparison :—

Assume gross area of holding in acres

100

	Rs.		Rs.
50 acres of cotton at 13 maunds per acre at Rs. 10 per maund ..	6,500	27 acres of cotton at 10 maunds per acre at Rs. 10 per maund ..	2,700
10 acres of berseem fed to cattle ..		54 acres of wheat at 10 maunds per acre at Rs. 5 per maund ..	2,700
16 acres of wheat at 10 maunds per acre at Rs. 5	800		
Total ..	7,300	Total ..	5,400

In one case 66 acres and in the other case 81 acres are brought under tillage hence the cost to the cultivator is greater in the latter case more especially as wheat demands more labour than cotton. The cultivator in one case starts the following year with 34 acres of rested land and in the other case with 19 acres.

Hence I infer that the cultivator stands to lose all round under the Baker-Lane scheme.

The water for sowing the wheat would be found in this way. 16 acres of wheat demand the water required by 8 acres of cotton (if duties are 2 : 1). Hence the 50 acres of cotton would have to be deprived of $\frac{8}{50}$ths of their water during a period sufficient to give the wheat area a delta of, say, 8 inches. This could be done at discretion between 1st August and 30th November during which time the cotton delta would be some 28 inches. Now $\frac{8}{50}$ of 28 equals $4\frac{1}{2}$ inches which in my opinion could be spared without prejudice to the cotton.

III.

I stated that the Baker-Lane scheme was not unsound agriculturally but I pointed out one formidable difficulty, *viz.*, the loss of soil fertility which makes the scheme dependent upon the widespread practice of substantial manuring, the source of which manure is not apparent. I might also have referred to another formidable difficulty if it had occurred to me at the moment, *viz.*, the labour problem : 12 lakhs of acres of wheat are contemplated though I gather the whole of this may not be taken in the estimates ; whatever area is taken in the estimates, however, will be a high figure. At Mirpurkhas I find a pair of bullocks can sow about 5 acres of wheat (carefully). The population will have to be very large and virile if 12 lakhs of acres are to be sown in 2 months at a time of the year when human vitality falls to its lowest ebb, unless malaria disappears. Under the Baker-Lane scheme the labour demand on any one day during the rabi season will be approximately 8 times as much as that on any one day in the kharif season (area double work double, time half).

In view of these two difficulties a Sind farmer will not be in a very enviable position under the Baker-Lane scheme.

IV.

Mr. Baker objected to Mr. Main's scheme because people would never carry it out unless the price of cotton remained relatively very high. I do not agree in this opinion for two reasons :—(1) It will be still more difficult to persuade the people to grow 12 lakhs acres of wheat, (2) the price of cotton is not likely to fall below Rs. 10 per maund whereas the price of wheat is likely to fall below Rs. 5 per maund in my opinion.

V.

Conference proceedings made it clear that my scheme could not be accepted as it stood on two grounds :—

(1) Financial and (2) Engineering.

It is for the financial and engineering authorities to state their irreducible minima and maxima requirements when it will become possible to see whether my scheme can be modified to meet those requirements, *e.g.*, would a 40 per cent. cotton intensity be practical from their points of view ?

VI.

It is stated in the minutes that the general opinion was obvious that the Baker-Lane scheme should be proceeded with, and Mr. Main was content to leave it at that. I am prepared to abide by this decision provided the Commissioner in Sind rules out my scheme (modified as suggested) but I wish it to be understood that I retain the personal opinion that the Baker-Lane scheme is mistaken in principle in developing the country on a wrong agricultural basis (wheat). The scheme in fact appears to be designed with two objects in view :—

(1) To secure a lucrative commercial investment for Government with the smallest possible risk.

(2) To make the problem as simple as possible for the engineers.

APPENDIX II.

Notes by Mr. Baker on Appexdix I.

Para. II.—These figures are obtained by assuming that the outturn of cotton is 13 maunds per acre and the price Rs. 10 per maund. My figures were 6 maunds and Rs. 9 per maund. No reason is given for this, and no similar addition has been made to the wheat figures. But for this the value of cotton would be Rs. 2,700 instead of Rs. 6,500, which makes all the difference. Sixteen acres of wheat is added to the fifty acres of cotton. Presumably this is bosi wheat. Yet the outturn is shown at the same rate as irrigated wheat. If this is right, why irrigate wheat at all? Yet Main himself suggested that our rabi duty was too high.

Para. III.—The point about labour and oxen is a good one, but I think it tells against Main's scheme rather than ours. He also wants 1,200,000 acres cultivated in one season and allows no other season. I do not see why wheat sowing cannot be spread out about as long as cotton sowing. Besides, the Sindhi wheat grower and his oxen are capable of remarkable efforts at times as is often seen in the Rohri wheat country and the Johi rain lands. However, we allow a whole generation for the necessary increase in men and cattle. Up till about 1950 we estimate only 7½ lakhs of wheat and require no more to make the scheme pay well.

Para. V.—I do not think it is a question of irriducible minimum requirements. The farther one gets from the ideal of an equal discharge throughout the year, the greater the engineering difficulty and the less the profit. To fix a financial minimum here and now is impossible. It would be necessary to know what the rate of interest would be in future years. It is useless to consider Main's concession of 40 per cent. cotton instead of 50 per cent. unless he also concedes that cotton should not be watered in the cold weather. As it is, rabi can only be provided for by enlarging the canal, which cannot possibly pay.

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APPENDIX III.

Notes by Mr. Tamhane on some of the points raised by Mr. Main at the Irrigation Conference held at Karachi on 3rd February 1919.

Mr. Main remarks—"Wheat cultivation would exhaust the soil in Sind quicker than any other crop except juwari. Irrigated wheat in constant succession might ruin the fertility of the soil in ten years and would be a heavy tax on fertility even if aided by rotations with pulses and other nitrogenous crops."

In my opinion if irrigated wheat be compared with irrigated cotton, which Mr. Main has in view, it would be found that although the exhaustion of soil perhaps is more intense in the case of irrigated wheat, the limit of soil exhaustion is confined mostly to the first foot of the soil, as the roots of wheat do not penetrate the soil much deeper.

In the case of irrigated cotton, however, it is common to find that the roots penetrate the soil much deeper and 2 to 3 feet depth would not be found unusual. The limit of soil exhaustion is accordingly much more in the case of irrigated cotton, though the exhaustion in the case of wheat may be more intense in Sind soils.

The wheat crop moreover occupies the land for about five months of the year whereas cotton crop stands in the fields for about ten months. The field therefore has seven months' rest in the case of wheat whereas in the case of cotton it is only two months. Besides, the tillage operations cannot much affect the deeper layers of soil to which the cotton roots go.

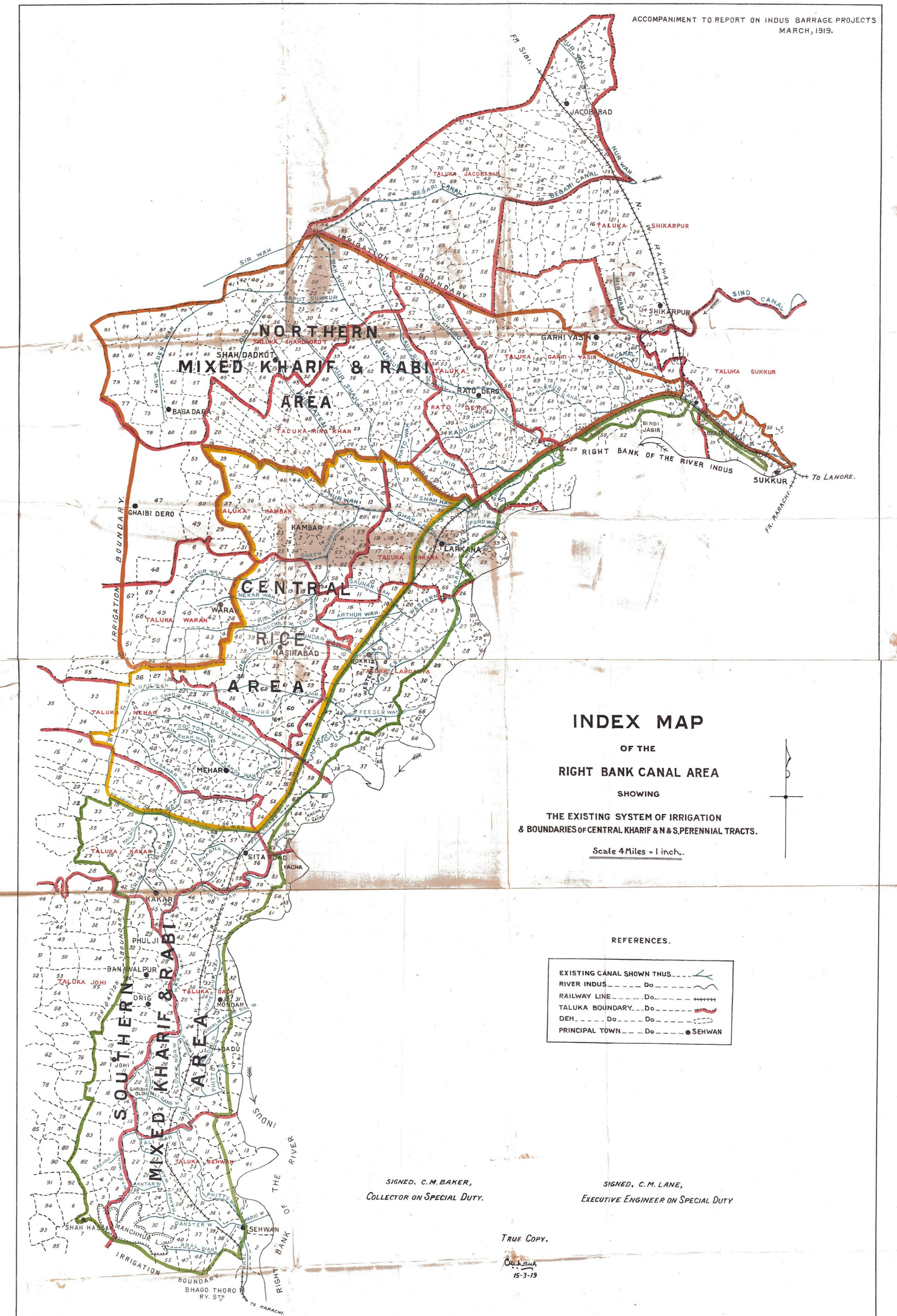
If however for any reason it is found that the wheat crop exhausts the soil much more and makes the land unfit for growing wheat within a few years, it may be due to "The Law of Minimum" which states that howsoever a soil may be rich in other ingredients of plant food but if it is deficient in any particular ingredient below its limit of mimimum the crop will fail. The demand on plant food being different for different crops, the soil may be exhausted for one particular crop but not for any other.

I am therefore of opinion that wheat, which is not only a food crop, helping to protect the country against famine, but is one which also brings in more revenue to Government in the form of water tax than cotton does, should, if possible, receive as much attention as cotton on the left bank canal of the Indus Barrage Project.

I may here note that Mr. Main's experience of Sind and general agriculture is infinitely superior to that of mine but I have recorded what I think of the whole situation.

The Times Press Bombay,—J. 2818-23.

ACCOMPANIMENT TO REPORT ON INDUS BARRAGE PROJECTS
MARCH, 1919.



INDEX MAP

OF THE

RIGHT BANK CANAL AREA

SHOWING

THE EXISTING SYSTEM OF IRRIGATION
& BOUNDARIES OF CENTRAL KHARIF & N & S. PERENNIAL TRACTS.

Scale 4 Miles = 1 inch.

REFERENCES.

EXISTING CANAL SHOWN THUS	
RIVER INDUS	Do
RAILWAY LINE	Do
TALUKA BOUNDARY	Do
DEH	Do Do
PRINCIPAL TOWN	Do ● SEHWAN

SIGNED, C. M. BAKER,
COLLECTOR ON SPECIAL DUTY.

SIGNED, C. M. LANE,
EXECUTIVE ENGINEER ON SPECIAL DUTY

TRUE COPY.

15-3-19

G.H.E.O. 1923