

**CENTRAL BOARD OF IRRIGATION
AND POWER**

PUBLICATION NO. 43

LAND RECLAMATION

VOLUME I

BY

M. L. MEHTA

**Director, Land Reclamation, Punjab
(India)**



सत्यमेव जयते

PUBLISHED BY ORDER OF THE BOARD

U. D. CLASSIFICATION 631.61

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May 15, 1951

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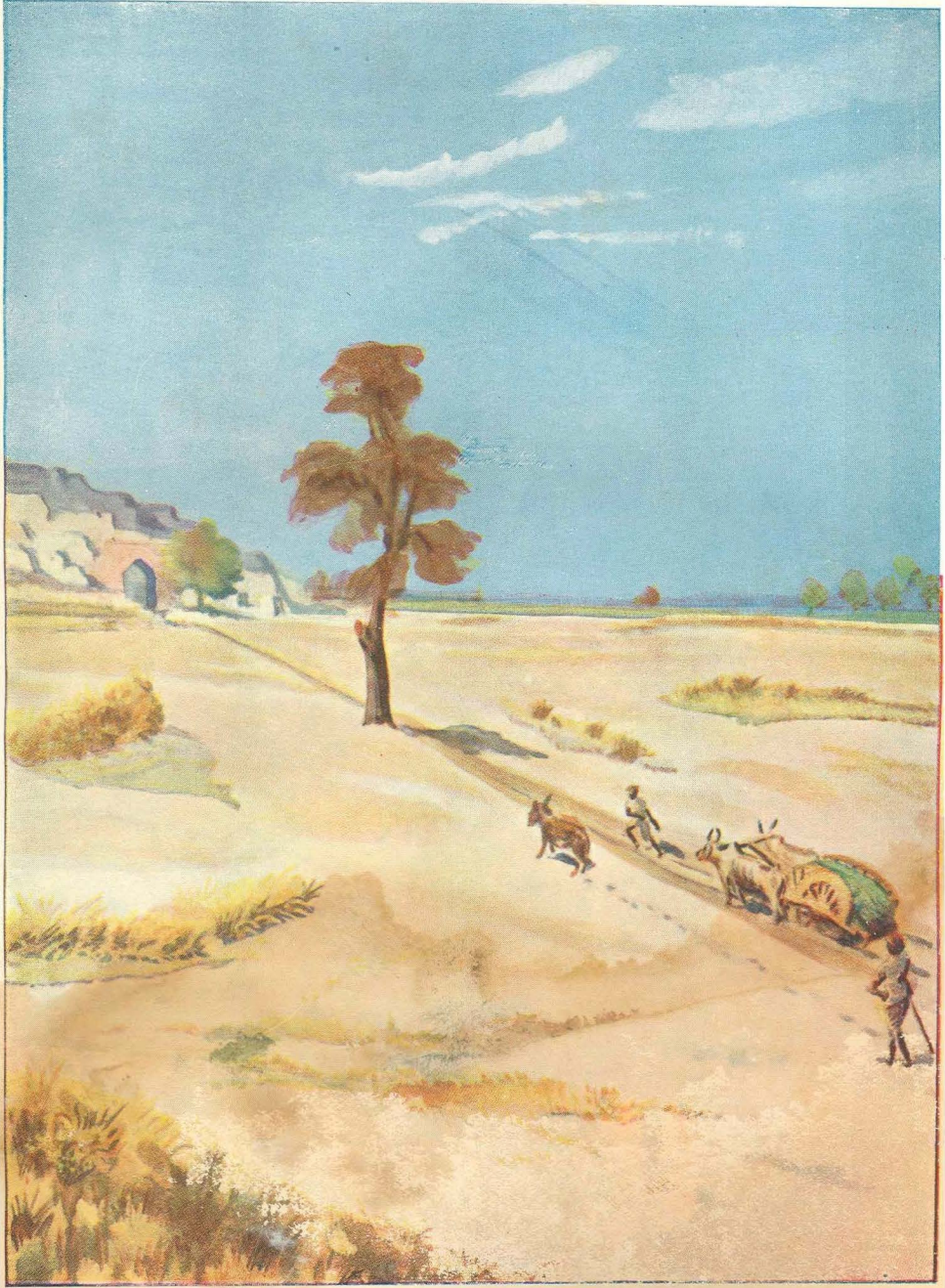
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*Good land slowly and gradually became their salt land
(Land before reclamation)*

FOREWORD

The term 'land reclamation' has been implied to mean in U.S.A. and other countries, the development of irrigation and cultivation in new and uncut lands. In India in the past the term 'land reclamation' has been used specifically for the reclamation of deteriorated and water logged lands infested with salts, but now under the pressure of growing more food, this term is being used also for bringing waste and uncultivated lands under cultivation.

In the pre-partitioned Punjab, magnificent and extensive irrigation systems were developed especially in its western portion. These resulted in intensive irrigation on new lands and brought prosperity to the State and the people, which was, however, accompanied by the evil of water logging and deterioration of lands due to rise in the water table consequent on seepage from canals, distributaries, water courses and fields. This deterioration of land due to water logging assumed a serious form and threatened the prosperity of the province. The Government of the Punjab as a result, instituted a Water Logging Enquiry Committee in 1925 to study the problem. The Irrigation Research Institute, Punjab, Lahore was also established about the same time and in addition to other studies of hydraulic and irrigation problems, the main investigation that had to be undertaken and which actually led to the inauguration of the institute, was a study of the deteriorated lands and methods to be adopted for their reclamation. Since then the Punjab Irrigation Department have done extensive work on studies on "land reclamation", both in the laboratory and the field and have been successful in reclaiming large areas which had gone out of cultivation due to salts or *thur*. As the development of irrigation was mainly confined to the western portion of the Punjab (now in Pakistan), the problem of water logging was also being studied in that portion. Shri M. L. Mehta, the author of this publication was connected with these investigations from the very beginning and to him goes the credit of development of the methods of reclamation which at the time of the partition were being successfully applied. The problem after the partition has been studied in the Indian portion of Punjab also, as there are vast areas on the Western Yamuna Canal and Sirhind Canal, which require attention, but were not being attended to before the partition. Naturally, therefore, the investigations described herein have all been carried out in the West Punjab and Shri Mehta has put them together for the benefit of all engaged on land reclamation.

The subject of land reclamation has engaged the attention of the Board since its institution in 1930 and has been discussed at every Board and Research Committee meeting. A questionnaire on land reclamation and water logging was prepared in 1935 to ascertain the

(ii)

present state of knowledge and to compare different conditions in various parts of India and a note based on the information received from various Provinces was published in 1938. The Executive Committee of the Board in 1949 felt that time had come when the Board should publish a comprehensive publication on land reclamation, based on the experience gained in different parts of the country. Shri M. L. Mehta, Director, Land Reclamation, Punjab (India), who has been connected with the subject for a long time, was requested to prepare a draft in association with Dr. R. C. Hoon, Dr. N. K. Bose and the Bombay Public Works Department. Shri Mehta has prepared his portion for the practice of reclamation, as evolved and followed in Punjab, where the problem was very acute and was studied minutely. His portion is, therefore, being published as Volume I and it is proposed to publish the contributions from others, which will deal more with the chemistry of soils, reclamation of tidal areas and reclamation of land in Deccan, in Volume II, subsequently.

Shri M. L. Mehta, the author of this volume has presented a fairly complete and upto date version of the science, as developed and followed in the Punjab. All the factors contributing to deterioration of lands, the different methods of treatment and preventive measures have been discussed in detail in Chapters 1 to 10, which will be of general interest. The remaining chapters are of local interest to the Punjab and contain details of this system, especially from administrative point of view as practised in the Punjab. It is hoped that the book will be equally useful to the soil chemist, the practical farmer and the irrigation engineer and will focus attention of all interested in the advancement of knowledge on the subject.

S. L. MALHOTRA,

Secretary,

May 21, 1951.

Central Board of Irrigation and Power.

PREFACE

The information given in this book is based on more than twenty years' experience of work done in the laboratory and in the field, both under government control and on thousands of acres of deteriorated land reclaimed and farmed by zemindars themselves.

With the dissemination of knowledge bearing upon *thur* formation and a general recognition of the terrible risks of rise of water-table in soil profiles with a zone of salt accumulation, it is to be hoped that reclamation projects would be taken up one after the other and that the days of land deterioration will be closed for ever.

No price would be too high to pay for absolute security of land against deterioration. It is a matter of satisfaction that the costs of reclamation at the present prices of agricultural produce are not high. In fact land reclamation now is a self paying proposition.

It is now an admitted fact that there is an intimate relationship between the quality of the soil, the nutritive quality of the plants that grow on it, and the health of those who eat these plants. Poor and deteriorated land makes people poor and sickly; and poor, sickly people make poor land poorer. Every one of us, therefore, no matter where one lives, in a rural area or a suburban town or even in a big city—has a major stake in the land. Good health is primarily a matter of good nutrition.

It is the duty of all to save this great heritage (soil) from damage. If we do that, it will enable us to build a better world for our children and our children's children.

M. L. MEHTA.

APPENDIX I

Organisation for Land Reclamation Staff

1. Land Reclamation Officer	1 for each canal system where reclamation water-supply exceeds 300 cusec.
2. Deputy Collector Reclamation	1 with each Land Reclamation Officer
3. Asstt. Land Recl. Officers	1 for every 200 cusec of recl. water-supply
4. Zilladars Reclamation	1 for every 50 cusec of reclamation water-supply
5. Reclamation Supervisors	1 for every 100 cusec. 1 extra for recording results and preparation of schemes in L.R.O.'s office.
6. Reclamation <i>patwaris</i>	1 for every 8 cusec on perennial canals, on non-perennial canals where recl. water-supply is available late, 1 for every 10 cusec.
7. Research Assistants for analytical work	1 for every 200 cusec. of recl. water-supply
8. Laboratory Attendants	1 for every 200 cusec of recl. water-supply
9. Asstt. Lab. attendants	2 for every 200 cusec of recl. supply
10. Peons	1 for each Gazetted Officer. 2 L.R.Os. Office
11. Khalasis	1 for L.R.O 1 for AL.R.O.'s office 1 for each Gazetted Officer
12. Sweepers	1 for L.R.O.'s office
13. <i>Chowkidars</i>	1 for L.R.O.'s office
14. Sweeper-cum- <i>Chowkidar</i>	1 for each AL.R.O.'s office
15. Office Establishment	1 Head Clerk 1 Accountant 2 Accounts Clerks 5 Assistant Clerks
	<i>Detail</i>
	1 Record Keeper 1 Despatcher 1 Camp Clerk 2 Assistants in accounts branch
16. Asstt. Land Recl. Officer	1 Sub Divisional Clerk in each Sub-division
17. Guard Establishment	1 Daffadar and 3 Barkandazes for the whole of the division

Duties of Land Reclamation Staff

After approval of the Land Reclamation Board, in the month of August each year, orders are issued by the Chief Engineer regarding the total water supplies that are to be utilised for reclamation of *thur* land in the following *kharif* on each canal system. Instructions regarding land reclamation technique and the distribution of water-supplies are also issued by the Chief Engineer from time to time.

Out of the total water-supply allotted for reclamation by the Chief Engineer, the Superintending Engineer will allot to each canal division the water-supply that can be utilised in that division. The allotment made by the Superintending Engineer will be made known to the Land Reclamation Officer for the circle and also the Executive Engineers concerned.

In no case will the Superintending Engineer allow any change in the land reclamation technique or the method of distribution of water laid down by the Chief Engineer without the Chief Engineer's consent.

From the results of the *Thur Girdawari* that would be available with the Executive Engineer and the results of land reclamation operations carried out previously and, also on the basis of the local conditions, the Executive Engineer and the Land Reclamation Officer will prepare schemes for the distribution of the supplies allotted to the division to the distributaries selected for reclamation by them. They will also indicate reaches of distributaries where they want to utilise the entire water supplies for the year and also submit programmes of land reclamation of the whole of the *thur* area on each distributary. Programmes thus prepared will be sent to the Superintending Engineer by the Executive Engineer for approval. Copies of approved programmes will be sent to the Land Reclamation Officer by the Superintending Engineer. The Land Reclamation Officer will then proceed to work in close collaboration with the Executive Engineer and work out the water supplies that are to be utilised for land reclamation on each outlet. Knowing the supply in each outlet, he will proceed to select with the help of his own staff fields for land reclamation. In this he will be guided by the orders issued by the Chief Engineer and the Superintending Engineer. When lists of areas are all ready, detailed proposals for areas selected for reclamation and the extra water supplies that are to be given to the outlets selected on each distributary will be submitted to the Superintending Engineer under the joint signatures of the Land Reclamation Officer and the Executive Engineer. The Superintending Engineer will then sanction the proposals and ask :—

- (i) the Executive Engineer to prepare estimates for remodelling and installation of additional shoots.
- (ii) the Land Reclamation Officer to make preparations for the commencement of reclamation during the following *kharif*.

Any alterations in the water courses and the *chakbandis* and proposals for new water courses which are considered necessary by the Land Reclamation Officer for purposes of reclamation will be carried out with the previous approval of the Executive Engineer.

At the end of each *kharif* season, the Land Reclamation Officer will supply the Executive Engineer lists of fields that he considers have been completely reclaimed.

The Land Reclamation staff, *viz.* the Deputy Collector Reclamation, the Assistant Land Reclamation Officer, the Reclamation Zilladars, the Research Assistants and the Reclamation *Patwaris* will, both for administration and technical supervision, be under the complete control of the

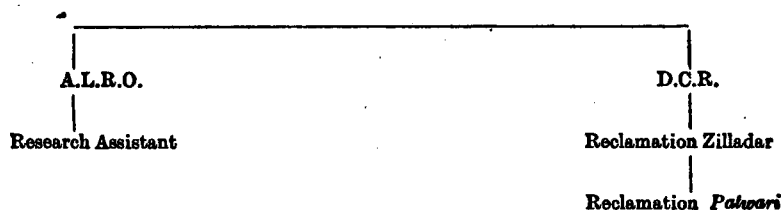
Land Reclamation Officer. They will work under his orders. The Land Reclamation Officer will write their qualification reports.

The Land Reclamation Officer under the Superintending Engineer will also have the general control of land reclamation in the circle. He will be responsible for supplying the Superintending Engineer all information regarding progress of land reclamation, prepare annual reports of reclamation operations and also proforma accounts for the circle. He will obtain from the Executive Engineers the works expenditure on remodelling and provision of extra shoots for land reclamation.

The Land Reclamation Officer will be invested with the powers of a Divisional Canal Officer under the Canal Act for the areas under reclamation and those of an Executive Engineer regarding matters of establishment, sanctioning of contingent expenditure etc. He will check at least 5 per cent. of the area under reclamation in the circle.

The organisation of the staff working under the Land Reclamation Officer will be as follows :—

L.R.O.



Assistant Land Reclamation Officer.—He will have the same status as that of a Sub-Divisional Officer in an irrigation Sub-division. He will be incharge of land reclamation of the area allotted to him. He will supervise the work of the Research Assistants, Reclamation Zilladars and Reclamation *Patwaris*. In the supervision of the work of the Reclamation Zilladars and Reclamation *Patwaris* he will work in close cooperation with the Deputy Collector Reclamation as regards revenue matters. He will check at least 30 per cent. of the area under reclamation in his charge and all fields for which remission is recommended by the zilladars.

Deputy Collector Reclamation.—He will supervise and check the work of the Reclamation Zilladars and *Patwaris* in respect of revenue matters. He will see that the instructions issued for the guidance of the reclamation staff are properly carried out by them.

He will get special *warabandis* prepared through the reclamation staff and verify them at site before submission.

He will get indents of *khasras* and other relevant forms prepared in time.

He will go round reclamation areas and also check working of reclamation *warabandis*.

He will be responsible for compilation of remission statements.

He will check at least 10 per cent. of the area under reclamation in the circle.

Reclamation Zilladar.—He will prepare a map showing the *chakbandi* of outlets and the area to be reclaimed in each square.

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He will supervise the registration of irrigation for reclamation done on each outlet which will be recorded by the Reclamation *Patwari* in the *shudkar khasra*.

He will verify the names of the cultivators and crops.

He will maintain records of weekly and monthly progress of land reclamation by each outlet and submit the same to the Assistant Land Reclamation Officer who will submit to the Land Reclamation Officer.

He will prepare *warabandi* of each outlet according to instructions and submit them for sanction to the Land Reclamation Officer through the Deputy Collector Reclamation.

He will report to the Assistant Land Reclamation Officer names of zamindars who are found using reclamation water in the area not selected for reclamation.

He will induce the share-holders to make their water-courses straight and line them to reduce seepage losses.

He will report to the Assistant Land Reclamation Officer on the condition of crops and any calamities that may occur.

He will go round the reclamation area as often as possible and see that, during the period of leaching and the growth of rice, each field receives irrigation on dates mentioned in the modified *warabandi*.

He will see that the zamindars on each outlet have laid their fields in quarter acre plots with a water course in the middle and report to the Assistant Land Reclamation Officer the names of those who are defaulters in this respect.

He will work out the quantity of rice seed required by each cultivator and distribute the same to them from the pure seed supplied to him by the Land Reclamation Officer and maintain the *taccavi* forms. He will also be responsible for the realisation of the *taccavi* amounts so advanced. All *taccavi* accounts will be maintained by him.

He will record observations of areas reclaimed, crops grown in reclaimed fields and the yields obtained.

Any wilful negligence on the part of zamindars in the matter of land reclamation operations in the field and the weeding or manuring of crops (when manures are sanctioned against *taccavi*) will be reported by the Reclamation Zilladar to the Assistant Land Reclamation Officer who will report the same to the Land Reclamation Officer. The Land Reclamation Officer will take steps to warn the cultivators that, if they do not work according to their instructions, they are not likely to be given *kharaba* or extra water for land reclamation during the following year.

It will also be his duty to see that all land reclamation operations, viz. laying of fields and water courses, leaching, sowing of rice nurseries, transplanting and harvesting of rice during *kharif* and sowing of leguminous crops during the *rabi* are carried out on dates specified by the Land Reclamation Officer.

He will check all fields under reclamation and record his appraisal in the *khasra* against each field.

Reclamation Patwari.—He will prepare a sketch on the first page of the *khasra* and show the area selected for reclamation on each outlet.

He will book all irrigation done in the reclamation area.

He will be responsible for keeping entries in *Khasra Shudkar* up-to-date and total entries of each day of his round in the reclamation area.

He will keep the *jinswar* of the crop on each page.

He will make correct entries in the *khasra* in respect of name of owner, cultivator, crop, area sown etc.

He will help the Zilladar reclamation in the preparation of *warabandi* lists.

He will have to go round his area once every 5 days.

He will see that water is rightly distributed according to the sanctioned *warabandi*.

He will report any wastage of water or unauthorised irrigation.

He will report any wide-spread calamity or any disease on crops in the locality.

He will supervise all reclamation operations under the guidance of his officers.

Research Assistants.

1. From January 1st to March 31st, the Research Assistant will be fully busy with the soil sampling of fields selected for reclamation during the following *kharif*. Soil sampling will be done with the help of a boring tool supplied by the department but in areas representative of typical soils, he will have soil profiles dug, examine them, take detailed profile notes and also take soil samples. In examining the soil profile he should note :—

(a) The thickness of the soil crust.

(b) The structure of the soil crust.

(c) The zone of accumulation of salt.

(d) The *kanker* bed and the thickness of the *kanker* nodules, their shape and their probable composition; also if they are small size pea-*kanker* or big nodules of calcium carbonate or calcium sulphate. The mechanical texture of the soils below and above the *kanker* zone must be carefully observed and recorded. The depth of the sub-soil water should be noted. This is always helpful in interpreting the formation and growth of the *kanker* bed.

The degree of the wetness of the soil above the *kanker* bed; the *kanker* bed itself and the soil below the *kanker* bed and also the degree of plasticity of all these layers must be carefully determined. With the help of a pH testing set the Research Assistant should determine, as far possible, the pH values of the soils of the three zones, viz. above the *kanker* bed, the *kanker* bed and below the *kanker* bed.

(e) From the point of view of moisture gradients, viz. the 'pellicular zone' the 'Field Moisture capacity zone' and the 'Capillary zone' the Research Assistant can make extremely useful observations which will be helpful in the practice of land reclamation. He should record the relative depths of these zones and indicate the depth of the soil crust which is affected by evaporation and which therefore, should be included in the 'Pellicular zone'. If this differs in different areas, he should bring this to the notice of the Land Reclamation Officer who will modify the land reclamation technique for that area.

(f) In fields, where deterioration has recently started and where some crops had been grown before land reclamation was proposed, it will be useful if he, during the course of his observations records the depths to which the roots of crops have penetrated. In fields which have been abandoned for years flora typical of deteriorated lands must have grown, the depths to which their roots penetrate should also be recorded. It will be necessary to record the names of plants that grow on such lands.

(g) The colour of the horizons in the freshly exposed profile, if recorded, always leads to useful indications in the proper handling of soils and the study of other soil problems.

2. From April 1st to September 30th, the Research Assistant will begin to get results of analysis from the laboratory. He has been supplied printed ledgers together with binders for recording results of analysis of fields proposed for reclamation and under reclamation. He should record these results and study the behaviour of these fields during leaching and the growth of rice. This work he should do in the Headquarters office of the Land Reclamation Officer.

3. An important observation which he can make during leaching and reclamation is the time taken for the water in the fields to disappear. If during the course of observations he finds that in a certain field water stands at the soil surface for a considerable period and does not percolate through, he should bring this to the notice of the Land Reclamation Officer and himself make a detailed study of the field to devise ways and means by which percolation can be improved. In no case should the zamindars be allowed to do puddling before transplanting rice. This process of puddling brings about impermeability which prevents the movement of the salts from the soil surface to the lower layers.

The Research Assistant should tour the area throughout the reclamation period and should bring to the notice of the Reclamation Zilladar instances of ploughing under water.

4. From the type of vegetation and the intensity of its growth during leaching, the Research Assistant should be able to form an idea of the amount of carbon dioxide generated by such vegetation and the degree to which the alkalinity will be reduced during the leaching period. If careful notes are taken by the Research Assistant, he will find them useful in interpreting his results of analysis after rice and the yields of rice with respect to the stage of reclamation reached.

5. At the time of the harvesting of rice, the Research Assistant should bring to the notice of the Land Reclamation Officer, factors which have made reclamation successful.

6. From October 1st to the end of December, the Research Assistant will be busy again in soil sampling and in taking notes on soil profiles. He should repeat all observations on soil profiles which he made before starting land reclamation to study the changes that have taken place as a result of leaching and the growth of rice.

7. Instances where small patches of unreclaimed land in whole fields are left after reclamation will come to the notice of the Research Assistant. If the patches are insignificant then they can be left and reclamation shifted to other areas. But certainly it is the duty of the Research Assistant to make a thorough study of the un-reclaimed patches and submit reports to the Land Reclamation Officer or the Assistant Land Reclamation Officer who will give the required advice to the zamindars.

8. It is a matter of common observation that in fields having a high clay content the residual alkalinity after leaching is high. If it is due to buffer action it may not affect the yields of normal crops on zamindari supply; otherwise the yields are bound to be low. During his tours the Research Assistant should keep an eye on fields declared reclaimed and take soil samples for examination whenever he finds he is likely to get useful results.

9. If reclamation has been undertaken in high water-table areas with the help of field and subsidiary drains, the Research Assistant should take, as frequently as he can, samples of water from the drains to determine conductivity, salt content and pH values.

APPENDIX II

Conditions of leases for Reclamation of Govt. waste Land

- (1) The tenancy shall be for a period of 12 harvests.
- (2) The area given on lease will be allotted the normal water allowance both for *kharif* and *rabi*. In addition extra water for reclamation will be given only in *kharif* on the basis of one cusec for every 45 acres, either in a separate water-course or by an additional pipe in the existing water-course and an increased *wari*.
- (3) For the first four *kharif* seasons the reclamation water-supply will be charged at half the divisional rates, thereafter full divisional rates will be levied. In *rabi* water-rate will be charged at normal rates. Land that is declared reclaimed by the Land Reclamation Officer will be cultivated on the normal water-supply.
- (4) No land revenue or malikana will be charged for the first four harvests. Thereafter Rs. 1/8/- land revenue and Re. -/12/- malikana will be levied. If after the termination of the lease, the tenant elects to purchase half the area the land revenue on that area will be determined under Section 59 of the Land Revenue Act.
- (5) At the expiry of the period of lease, if the tenant has worked according to the satisfaction of the Land Reclamation Officer, the area of the block will be divided at the discretion of Government into two equal halves, one of which will be resumed by the Government and for the other the tenant will be given the option to obtain proprietary rights at the rate of Rs. 150 per acre. The total price of the land thus fixed will be recovered from the tenant, in twenty equal half yearly instalments, in ten years.
For non-perennial areas in the Sutlej Valley and also on the Rangpur Canal the rate will be Rs. 75 per acre.
- (6) The lessee is required to have the land cultivated by employing labour. In no case will he be permitted to employ tenants on *batai* till the land is completely reclaimed. Portions of land which are declared reclaimed by the department can be given on *batai* to tenants.
- (7) The lessee shall have to reside permanently in the estate in which the said land is situated within one month of the date on which the Collector passes an allotment order and within three months of the same date he shall construct temporary buildings residential and non-residential to the satisfaction of the Land Reclamation Officer on a site allotted and according to the plan approved by the Land Reclamation Officer.
- (8) The lessee will be required to arrange for accommodation for a Reclamation *Patwari* paid and appointed by Government for the supervision of reclamation.
- (9) The lessee shall have to carry out all operations regarding cultivation, layout of fields, construction of *bunds*, excavation of water-courses, leaching, and sowing of crops strictly in accordance with the instructions of the Land Reclamation Officer, both in land under reclamation and that declared reclaimed.
- (10) The lessee shall have to reclaim land according to instructions issued from time to time by the Director, Land Reclamation, and to comply with all such instructions and carry out all such orders without any objection or compensation.

APPENDIX III

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APPENDIX IV

Glossary of Vernacular terms

<i>Banjar</i>	Area not cultivated
<i>Bar</i>	uncultivated tract carrying wild tree growth
<i>Bara</i>	hard intractable piece of land
<i>Batai</i>	division
<i>Chak</i>	area within irrigation boundary
<i>Chhappar</i>	thatch
<i>Chit Dain</i>	infertile land devoid of vegetation
<i>Crore</i>	ten million
<i>Doab</i>	tract situated in between two rivers
<i>Girdawari</i>	survey including measurement of irrigation and crops
<i>Kankar</i>	stone nodules
<i>Kharif</i>	summer (April to September) crop harvested in Autumn
<i>Lakh</i>	one hundred thousand
<i>Malikāna</i>	cess
<i>Maund</i>	a weight measure equal to 82 lbs.
<i>Nallah</i>	a small rivulet
<i>Papri</i>	thin cake
<i>Patwari</i>	village revenue official
<i>Rabi</i>	winter (October to March) crops harvested in Spring
<i>Rakkar</i>	land highly alkaline
<i>Sem</i>	Water-logged land or water-logging
<i>Shor, Reh</i>	salts
<i>Tehsil</i>	a part of district
<i>Thur</i>	salt affected land
<i>Warabandi</i>	schedule of turns or time shares in water-supply from a water-course
<i>Wari</i>	a turn or time share of water-supply from a water-course

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