THE ECONOMICS OF LAND RECLAMATION IN THE FORMER SIND

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1. INTRODUCTION

Between 1959 and 1966 an extensive programme of agricultural and irrigation investigations was carried out in the former Sind, under the aegis of WAPDA. The work of the Lower Indus Project, as it came to be called, was entrusted to an association of two firms of consultants, Hunting Technical Services Limited being responsible for the agricultural and economic aspects of the work, and Sir M. MacDonald and Partners undertaking the engineering investigations. In 1966 the Lower Indus Report, embodying the data collected, describing the present situation, and formulating a Development Plan for the next 25 years, was published. This has formed the basis for subsequent planning work in Sind.

In the course of the investigations a lot of work was done on land reclamation. Attention was concentrated on the problems of reclaiming saline and saline/alkali soils, and it is with these that we are concerned here. Other aspects of reclamation, such as the levelling of sand dunes and hummocks, are deliberately ignored, except where large-scale reclamation in new areas is being discussed. The data and opinions given in this paper are based primarily on the results of the Lower Indus Project (LIP) work, and thus refer purely to the former Sind. Nevertheless, many aspects are also relevant to the former Punjab. The soil conditions of the two areas are generally fairly similar, although heavily alkaline soils are a greater problem in the latter.

The main objectives of this analysis of the economics of reclamation are to assess the returns to the economy and those to the individual farmer. From the viewpoint of the economy the important measure of its value is the degree to which it makes good use of those resources which are in short supply. Under present conditions water and capital are the scarce resources, and we should therefore measure the returns to these. To a considerable extent they are complementary, in that the supply of water can be increased by capital expenditure on storage works, canal enlargement, tubewells, etc. Thus the discussion can be conveniently confined to an examination of the returns to water. On the other hand, the farmer is concerned primarily with the cash profit which he will make out of reclaiming land. The distinction between the two cases is important, because different prices on inputs and outputs may have to be applied for each. For instance, the hiring of farm labour is a cost to the farmer but is not generally considered to be a cost to the economy. This is because for most of the year there is a surplus of farm labour in the rural areas, so that if a labourer is not hired he will have little alternative work. His employment on a farm will not result in any significant loss in output elsewhere, and therefore his 'opportunity cost' is zero.

In this paper the economics of reclamation are examined on two scales; firstly, the small scale, involving the reclaiming of small pieces of land within an area which is already cultivated; secondly, the large scale, which involves the development of large areas of uncultivated land by the construction of canals, drains, and other major works. Firstly, we will see how profitable reclamation is to the farmer, and will also assess the economic returns to the irrigation water used. In the second case, a basic policy issue is involved. Given conditions of general water shortage in West Pakistan, the question is whether it is better to follow a policy of intensive irrigation development, by concentrating the available water on a relatively small area, or to develop extensively, whereby much larger areas of land are reclaimed and cultivated, but at a much lower cropping intensity. This problem is of particular relevance to the Lower Indus region, where there are still large expanses of undeveloped land which could be brought under cultivation.

The paper is divided into three main sections. The methods and techniques of reclamation, and the technical data obtained from the LIP investigations, are discussed first. This is followed by a discussion on the economics of small-scale reclamation, after which the economic aspects of intensive and extensive large-scale irrigation development are examined. Particular attention is given to this question, because it is of such importance for the successful exploitation of the province's agricultural resources.

2. RECLAMATION TECHNIQUES AND RESULTS

Most of the undeveloped land in the former Sind has either saline or saline/alkali soils. Non-saline alkali soils, which are such a problem in Punjab, occur only rarely, while uncultivated land with low salinity or alkalinity status is also not common, except where regular flooding from the River Indus or from hill torrents occurs. Water-table depths vary enormously, but in a number of areas they are above 6—7 feet for much of the year. The LIP results quoted here refer to soils with water-tables below this depth. Above this level capillary movement of salts from the water-table to the land surface becomes significant, and a permanent reduction in the salinity and alkalinity of the topsoil is difficult to achieve. In this case the farmer is unlikely to be able to reclaim the land successfully, and the only long-term solution is to lower the water-table by tubewells or drains. Once this has been done, the reclamation procedure is similar to that described for soils with deeper water-tables.

The simplest and most effective method of reclaiming saline and saline/slkali soils is that of leaching, which is the normal method used in Sind. Large quantities of water are applied to the land, and as this water infiltrates, the salts in the soil through which it passes go into solution and are carried down by the percolating water.

The research undertaken by LIP was devoted primarily to studying this type of reclamation, and comprised the monitoring of 39 sites on nine farms where reclamation was in progress, leaching studies with concentric steel cylinders, and detailed experiments on a separate reclamation research farm at Khairpur. The main results to emerge from this work were as follows:—

1. The time required for successful reclamation of saline and saline/alkali soils is dependent on their initial salinity and alkalinity status, the soil texture, and the amount of water applied. For a medium-textured soil under perennial irrigation reclamation will generally take 1½—3 years, and 2½—5 years for heavy soils. The period required for heavier textures is longer because of slower percolation and the higher clay content, which means that the salts go into solution less readily than in lighter soils. In seasonally irrigated areas where irrigation water is available for only half the year, the process will take 1½—2 years longer than in a perennial system. After reclamation is complete a rehabilitation period of one or two more years will be required to reach 'normal' yield levels.

2. To achieve these results, however, efficient soil drainage is essential, for the removal of the leached salts. In the Lower Indus area this is usually adequate except, of course, where the subsoil water-tables are high. In this case successful reclamation is extremely difficult, because as soon as leaching stops the salts will return to the surface through capillary action.

3. The cultivation of crops is beneficial to the reclamation process. Another major advantage is that it enables the farmer to get some income from his land while it is being reclaimed. Cropping increases water penetration and mobilizes calcium from the

reserves of calcium carbonate in the soil and also improves the soil structure through the addition of organic matter.

For perennially-irrigated areas a rice-berseem rotation is best, although where alkalinity is disproportionately high an initial planting and green manuring of Sesbania may be necessary. The great advantage of rice is that it is reasonably salt-tolerant and can withstand large applications of water and the presence of standing water. Berseem is the most suitable rabi crop because it also has relatively high water requirements. In all cases a heavy preliminary leaching is advisable.

4. During the reclamation period, crop yields are much lower than under normal conditions, but the farmer should still receive some income from his land. Average yields for a typical Sind soil under reclamation in a perennial area, with and without the addition of fertilizer, are shown in Table 1. The application of fertilizers is usually advisable, to replace the nutrients lost during the leaching process, although at present it is not normal practice.

TABLE 1.—*Reclamation crop yields (maunds per acre).*

Crop	Fertilizer	Reclamation period (years) 1	2	3
Rice	O	5.0	7.0	10.0
	N	6.5	10.0	12.5
Berseem	O	50	90	180
	NP	90	190	280

O = Unfertilized N = 50 lbs. of urea per acre.
P = 100 lbs. superphosphate per acre
Source: Lower Indus Report, Table 11.6.

5. With heavy leaching the soils can become sodium-affected, leading to a reduction in soil permeability and making reclamation considerably more difficult. Special measures, such as the application of gypsum, then become necessary, to displace the sodium and improve the soil structure. However, this problem did not in fact occur on any reclamation sites investigated, and in no instance did gypsum prove necessary. This is chiefly due to the high natural gypsum content of the Sind soils.

6. On the farm sites that were studied, the average amount of water applied on reclamation rice was between four and five feet at the field. However, the applications varied widely from farm to farm.

3. THE ECONOMICS OF SMALL-SCALE RECLAMATION

3.1. Introduction

The value of reclaiming small areas of land has been assessed to establish the level of returns to the individual farmer and to the nation. Most of the cultivated area of Sind is farmed under the landlord-tenant system, so that the reclamation work is usually undertaken by the tenant and his own bullocks, with little hired labour or bullock-power being used. Labour and bullock costs can therefore be omitted from the calculations. There is generally surplus bullock-power available on farms in Sind, and the use of this spare capacity for reclamation involves little extra cost. This is because the costs of bullock maintenance and feeding are relatively fixed and do not vary significantly with the workload.

3.2. Farm Costs and Returns

The net returns from reclamation will comprise firstly the value of crop output while the land is being reclaimed, less the expenditure involved, and secondly, the returns which the farmer will receive from the land after reclamation is completed. Obviously the value of reclamation to the farmer, and his desire to develop uncultivated land, will depend to a great extent on its productive potential. This will in turn be determined partly by the irrigation supply available. Reclamation will often be more profitable in a perennially-irrigated area than in one with only seasonal supplies, because a higher cropping intensity and a greater income per acre should be possible.

The calculations have been based on the assumption that perennial irrigation is available. For rice the average farm-gate price of coarse-grained paddy used by the Lower Indus Project, Rs. 8.65 per maund, has been applied, with an addition of Rs. 0.50 per maund of grain to allow for the value of the rice straw produced. Berseem has been valued at Re. 1 per maund. Land revenue and water rates have not been charged for the reclamation period, because these are often waived. The fixed costs of farming, which comprise mainly bullock costs, are unlikely to increase very much when additional acreage on a particular farm is being reclaimed. They have therefore been omitted.

On the basis of the yield data given in Table 1, the net direct returns during the reclamation process are shown in Table 2. Three crops each of rice and berseem would be grown in the three-year period.

TABLE 2.—*Crop costs and returns during reclamation*
(Rs. per acre)

1. *Gross Output*		
Rice: 22 maunds over three years	..	201.30
Berseem: 320 maunds over three years	..	320.00
Total	..	521.30
2. *Production Costs*		
Rice seed	..	30.00
Berseem seed	..	45.00
Total	..	75.00
3. *Total Net Returns over three years*	..	446.30
4. *Average Net Returns per Annum*	..	148.80

With annual economic net returns per acre of about Rs. 150, the farmer should not incur a financial loss at least during the reclamation period. Even in the case of a landowner without tenants, who has to hire labour and bullock-power for the cultivation and reclamation work, the income from rice and berseem should go a long way towards meeting costs. Thus it can be concluded that in most instances the farmer will not lose money on reclamation.

3.3. Value of Alternative Uses of the Farmer's Resources

However, it is quite possible that he could achieve a higher income if his labour, bullocks and water were used for some other purpose, such as increasing the acreage of crops on the existing cultivated area. The most important point is whether by reclaiming land the best use is being made of the resources available. Water is the key factor here, for in spite of occasional seasonal shortages there is generally more than sufficient bullock-power and farm labour in Sind. The question which must then be answered is whether reclamation gives good returns to water compared with the alternative opportunities for using that water elsewhere.

The recommended summer application per acre for reclamation is six acre-feet at the watercourse head; this would allow for growing a crop of rice. Water use by berseem is assumed to average four feet at the watercourse head, Thus the total water used each year in reclaiming one acre of land is 10 acre-feet, giving a total of 30 acre-feet for the whole reclamation process. The value of the water applied is thus Rs. 446.30÷30, which is approximately Rs. 15.0 per acre-foot.

Cropping intensities in the perennial commands of Sind are normally low, rarely exceeding 100 per cent. In this case there should be abundant opportunity for using the 30 acre-feet for intensifying cropping on the existing cultivated area. The southern part of the Rohri Command is a typical example of a perennial area in Sind. Here two years ago, the cropping intensity was about 80 per cent, with 23 per cent of the land under cotton, 17 per cent under wheat, 15 per cent under Brassica oilseeds, and the remainder under fodder, coarse grains, pulses, and perennial crops. In such an area the most likely result of an increase in water supply would be a rise in the acreage of cotton and wheat. With the advent of Mexipak, wheat has become far more profitable than rabi oilseeds, and most of the additional rabi supplies would probably be used on wheat, especially as with only 17 per cent of the area under this crop at present the peaks in demand for farm labour and bullock-power for the harvest and threshing will not be too serious. With present irrigation practices the six acre-feet of water required for one acre of reclamation rice should be able to supply about 1½ acres of cotton. Similarly, in winter the water used for an acre of berseem would be sufficient to grow almost two acres of wheat.

On the basis of these assumptions we can now calculate the alternative value of reclamation water if it were used to intensify on the existing farmland. The data used to calculate the net returns from each crop are explained in Appendix 1.

The net returns from cotton and wheat, both to the nation and the farmer, are shown in Table 3. In the former case, labour costs have not been deducted, because they are not real economic costs. Similarly, water rates and land revenue have not been charged, since with canal irrigation an increase in cropped acreage does not in fact lead to a significant rise in economic costs. As with reclamation crops, farm fixed costs have been excluded.

The irrigation seasons of wheat and berseem are not exactly similar, because berseem has a longer growing period. But it can be assumed that the water needed by berseem outside the wheat season would be used on other crops if berseem were not grown. As regards wheat yields, a conservative figure of only 15 maunds per acre has been taken, to avoid the danger of overstating the value of rabi water.

From Table 3 it is possible to calculate the alternative value of reclamation water if used for intensifying cropping on the existing farm area. For reclamation six acre-feet per acre would be used in kharif and four acre-feet in rabi. The total alternative value of this water to the economy and the farmer would be as follows:—

		Economic value (Rs.)	Farmer's value (Rs.)
Six acre-feet of kharif water	..	303	255
Four acre-feet of rabi water	..	404	354
Total value	..	707	609
Value per acre-foot	..	71	61
Value per acre-foot used for reclamation	..	15	15

TABLE 3.—*Net returns from alternative uses of reclamation water (Rs.)*

		Farmer's value	Economic value
Cotton (Rs. per acre)			
1. *Gross output:*			
7 maunds at Rs. 30.75	..		215.00
at Rs. 29.00	..	203.00	
2. *Production costs:*			
Seed	..	12.00	12.00
Water rates and land revenue	..	21.00	
3. *Net output*	..	170.00	202.00
4. *Water use (acre-feet)*	..	4.0	4.0
5. *Value per acre-foot of kharif water*	..	42.5	50.5
Wheat (Rs. per acre)			
1. *Gross output:*			
15 maunds at Rs. 14.85	..		222.75
at Rs 13.85	..	207.75	
2. *Production costs:*			
Seed	..	10.00	10.00
Water rates and land revenue	..	12.00	
3. *Net output*	..	185.75	212.75
4. *Water use (acre-feet)*	..	2.1	2.1
5. *Value per acre-foot of rabi water*	..	88.5	101.0

From this comparison it is obvious that where insufficient irrigation supplies are available their use for reclamation is highly uneconomic, because the returns from irrigation on areas that are already reclaimed are so much higher. Since Pakistani farmers, including those in Sind, are for the most part highly receptive to economic forces, it is most unlikely that reclamation would be undertaken except where surplus water was available. It is better both for the economy and for the farmers themselves to concentrate supplies on intensifying cultivation on the present farm area.

However, once the demand for water has been satisfied and high cropping intensities and water applications per crop acre are achieved, land begins to replace water as the limiting resource. Water becomes surplus because insufficient land is available for it to be fully used. With present techniques the maximum intensity possible would normally not exceed 160-170 per cent, and when this level is reached the only way of increasing the total cropped acreage is by extending the area under cultivation. Thus land acquires a premium value, and reclamation immediately becomes a highly profitable undertaking, because it represents the key to further increases in production and incomes. During the reclamation period itself the net returns are naturally very low, even in a perennial area being less than Rs. 150 per acre from two crops per year. But once salinity and alkalinity have been removed and normal cropping becomes possible, returns of at least Rs. 200-500 per acre can be achieved, depending on the intensity of cropping.

Normally canal water is used for reclamation, but with returns of this magnitude the use of private tubewell water to reclaim additional land could be highly attractive, in spite of such water being considerably more costly. Of course, this is always providing that there are no further opportunities for expanding the cropped acreage on the existing cultivated area. In Appendix 2 the calculations of the cost of reclamation with private tubewells shows that this is reasonably profitable, and that the investment made through pumping the necessary water should be fully recovered within a year of reclamation being completed.

4. THE ECONOMICS OF LARGE-SCALE RECLAMATION

4.1. Intensive versus Extensive Development

It has been clearly demonstrated that on a farm scale where water is in short supply addidtional supplies must be used to intensify cropping on the existing cultivated area rather than to expand this area through reclamation. The same principle can be extended to cover situations where additional water is made available by large-scale engineering works such as storage dams, barrages, and tubewell projects. Water is so much more valuable when used for intensification that reclamation of new land should be undertaken only when spare supplies become available. On economic grounds such a policy of 'intensive' development must be preferred to the alternative of 'spreading' the water more thinly in order to extend the area under cultivation.

However, at first sight this policy appears to ignore some of the social and political factors involved in irrigation development. For a variety of reasons these forces tend to favour the development of the greatest possible area of land. More farmers are then able to participate in the projects, resettlement of people from other areas becomes feasible, and initially, at least, Government obtains the maximum political benefit. Moreover, it obtains substantial extra revenue from the sale of land. In economic terms the main benefit is likely to be the reduction of unemployment in a project area itself and in areas supplying farmers for resettlement.

These apparent advantages do not, however, by any means justify the 'extensive' approach. From the national viewpoint a far better allocation of resources may be obtained by encouraging the movement of the surplus unemployed population away from an area and aiming primarily at the maximum possible economic returns from each project. It may well be preferable to bear the social dislocations that such a policy will produce in order to gain the full benefits from intensive irrigation development.

The whole argument concerning this problem hinges on the assumption that water is in short supply. The irrigation system in Sind is dependent almost completely upon the River Indus. River flows are adequate between June and September, but are low during the period from October to May. Thus even a seasonally irrigated area, which takes water from April or May to October, is affected by shortages of river supplies, in this case at the beginning of the irrigation season. For a perennial area the problem is naturally more serious, because of the difficulty of maintaining adequate canal flows in the winter season. These can be increased above present levels by the construction of storage works or tubewells, but both are expensive.

At present there are almost six million acres of perennially-irrigated cultivated land in Sind, all of which is cropped at intensities of less than 100 per cent. A major priority of the development plan for the Lower Indus area is to augment supplies to these areas, but in view of the scale of the problem and the vast amount of capital investment required for tubewells, storage works, canal remodelling, and a new barrage at Sehwan, it is most unlikely that their demand for additional water could be fully met much before 1990. Thus we can assume conditions of regional water shortage for perennial areas for at least the next 20 years. In this case the problem of whether an intensive or extensive development policy is preferable becomes of crucial importance. Instead of increasing water supplies to the six million acres to achieve an overall intensity of 145-150 per cent, as is planned, much of the water could be used on the presently uncultivated areas in the Sukkur Right Bank, Nara, and Ghulam Muhammad Commands. The total cultivated area in Sind would thus be increased but the cropped acreage would be the same or perhaps even less than in the original plan. Crop production might well be reduced, because the lower intensity of cropping would lessen the degree of control over soil salinity and might lead to lower crop yields.

There seems little doubt that from the viewpoint of direct benefits and costs (*i.e.*, ignoring for the moment the economic costs of population movement and resettlement), the use of these limited water supplies through intensive development is preferable. On the costs side, it should bring economies in capital and annual costs in a number of ways. Heavy investment in drainage works will be required for most areas of Sind in the future. Much of this expenditure on drainage works will depend more on the extent of the cultivated area than on the drainable surplus per acre. This is particularly true of tile drainage, and to a considerable degree of both the smaller drains in a storm water drainage system and of subsoil water-table control by tubewells. In most cases an expansion of the cultivated area, even at a lower intensity of cropping, involves a corresponding extension of the total length of the drainage system and an increase in capital and annual costs. This argument also applies in the case of canals and water-courses, and even roads. Land clearance and development expenditure will be the same per acre of land, regardless of the future intensity of cropping, and in areas with uneven micro-relief and a heavy cover of bush this can be very expensive. In some areas, particularly certain parts of Gudu Left Bank, the use of bulldozers and tractors is essential for successful land clearance. Costs per acre for the clearance and levelling work alone can be as high as Rs. 500, a large proportion of which is foreign exchange required for the machinery used.

With intensive development the costs per crop acre for supporting services such as agricultural extension will be reduced. This is because these are determined primarily by the extent of the cultivated area and the number of farmers involved rather than the cropped acreage. Total farm costs per crop acre will also be lower, because of the decrease in the farm overhead costs. To some degree these depend on the size of the cultivated rather than cropped area. High intensities thus imply a reduction in cost per acre cropped, and higher net benefits. For instance, a farmer with 12 acres of land will have one pair of bullocks whether this land grows 10 acres of crop per year or 15.

Apart from these economies in cost which intensive development should bring, it is also likely to result in a reduction in canal and watercourse transmission losses and a higher proportion of the canal-head supplies reaching the field, simply because the total length of channels will be less. In fact, therefore, a given amount of water at the canal head will produce larger net benefits. Furthermore, in areas with relatively shallow water-tables, high intensities are more effective in controlling salinization of the land, because the low proportion of fallow land means that resalinization through the rise of salts from the water-table is prevented by the continual leaching that is taking place.

Intensive development, which involves little reclamation of new land, should therefore produce higher economic net benefits from a project, and a higher return per acre-foot of water. A greater volume of total income from a project will result in an increase in the national demand for goods and services, which will in turn generate additional income and employment in other sectors of the economy. By restricting the cultivated area, intensive development does of course limit the number of direct beneficiaries. While this may be considered undesirable on social grounds, it raises the farm income per head and results in a greater total volume of personal savings, which will then be available for investment in the economy. Another advantage is that the capacity of the farmers to repay the project costs is improved.

Thus intensive development should result in a reduction in a project's capital and annual expenditure per acre of crops. Direct benefits per acre-foot of water will be greater, and the ratio of primary benefits to costs will be considerably higher than in the case of extensive development. Against these advantages might be set the indirect benefits resulting from the increase in the number of people employed if the cultivated area is extended. There is unlikely to be any very significant rise in the total number of man-hours employment provided, but, as with water, it will mean that the available employment will be spread more thinly amongst a greater number of people (*i.e.*, each man will work fewer man-hours). This can be construed as a benefit only if surplus labour is available and unemployment is a problem. If labour becomes scarce, the relative under-employment of labour associated with extensive development will constitute a wasteful use of resources, in that considerable manpower, sorely needed elsewhere, is retained on the farms at a low intensity of employment. However, it seems unlikely that such a situation will develop for some time.

The indirect benefits from increasing the number of farmers in a project by using the available water to extend the area under cultivation rather than to intensify would be the costs of providing alternative employment. But it must be borne in mind that there would be some production from this alternative employment. This leads on to the crucial point, that investment in such forms of alternative employment is bound to produce higher returns than the corresponding volume of extra project expenditure requried to extend the area under cultivation, because extensive development of this kind *reduces* the direct net benefits; so the additional investment produces *negative returns*. It is thus far more advantageous to opt for intensive irrigation development, especially since the higher net returns that this induces will anyway lead to the provision of some alternative employment for those people who are left outside the project. Moreover, such a course of action would also be acceptable on social grounds, because, in view of the basic LIP criterion that all presently cultivated land should be developed anyway, the areas into which further expansion could take place have a very low population at present.

The paradox is, however, that extensification can bring higher apparent returns to Government in spite of its lower benefits to the economy. One of the chief sources of Government revenue from an irrigation project is the sale of Government-owned uncultivated land. A project which deliberately excludes the development of such land by concentrating on the existing cultivated area would thus deprive Government of a substantial volume of immediate revenue. In this case it is vital to distinguish between the financial returns (*i.e.*, the profit made by the project's operating authority) and economic returns. Projects must always be ranked primarily on the basis of their economic performance, because this establishes their value to the country as a whole rather than just in terms of revenue to Government.

4.2. A Case Study

To illustrate the economic consequences of intensive *versus* extensive development, an example of one project in the perennial area of Sind has been taken. This is the East Nara Tile Drainage Project, situated in the existing Nara Canal Command, and scheduled under the Lower Indus Development Plan to begin construction in 1981-82. Its total culturable commanded area (CCA) is about 420,000 acres of which almost half is predominantly saline-alkali, uncultivated land, with a high water-table. The plan proposes that this area should not be developed, and that out of the total of 420,000 acres only 246,000 acres should be provided with drainage facilities and additional irrigation supplies. All this land is already cultivated, at an average cropping intensity of 94 per cent.

The ultimate aim is to raise this to 150 per cent by enlarging the existing canal system and supplying the area from the proposed Sehwan Barrage. This is situated on the River Indus midway between Sukkur and Hyderabad, and will be both a diversion and a storage works. Subsoil drainage will be required for the project, to control the water-table. Due to the unfavourable nature of the aquifer, tubewells cannot be used, and resort will have to be made to tile drainage, which is considerably more expensive. The tile drains are laid 5-6 feet below the surface, and their discharge is lifted by small pumps into disposal drains and thence into the major drain which will serve this part of Sind, the Left Bank Outfall Drain. An electrification network will be needed to power the small pumps and the major pump stations which, where necessary, will lift the drain discharges into the Left Bank Outfall Drain. The drainage network will have sufficient capacity also to dispose of stormwater from the severe and damaging summer rainstorms which occur in the area.

To compare the economic returns from intensive and extensive development, an alternative plan involving the reclamation of 117,000 acres to raise the total development CCA of 234,000 acres (246,000 acres minus 5 per cent for future roads, drains, etc.) by 50 per cent has been examined. Assuming a fixed level of total water supply from Sehwan to the project, the ultimate cropping intensity would be reduced to approximately 100 per cent because of the increase in cultivated area.

Such a course of action would raise the construction cost of the project considerably, as is shown in Table 4. The changes, and the reasoning behind them, are explained in Appendix 3. The investment in drainage works and the electrification network would rise almost by half. Land development costs would be high, because the area of 117,000 acres would require development through clearance, levelling, and laying out the field pattern. Expenditure on canalization would not change much, because no major extensions to the existing canal system would be needed.

A major loss in benefits would occur through the increase in watercourse seepage losses and the use of a considerable volume of water for reclamation instead of additional cropping. The reduction in benefits that would result is calculated in Appendix 3.

The net effect on costs and benefits of developing the East Nara Tile Drainage Project extensively rather than as planned by LIP is shown in Table 4.

The analysis has deliberately been kept as simple as possible. For this reason the increase in annual costs that would undoubtedly occur has been excluded, and no allowance has been made for the rise in farm costs per acre cropped. Nevertheless, it indicates quite clearly the very high costs associated with extensive development. If the LIP plan for East Nara were changed to allow 100 per cent cropping intensity on 350,000 acres, capital expenditure would increase by some Rs. 185 million, while annual benefits would be reduced by Rs. 24 million. To contemplate incurring costs of this magnitude for the intangible and perhaps short-lived political and social benefits that would result is unthinkable.

TABLE 4.—*Effects of extensive development on costs and benefits of East Nara Project.*

(Rs. million).

	L.I.P. plan	'Extensive' plan	Net change
1. Increase in capital costs			
Tile drainage ..	312	468	+ 156
Drainage disposal ..	45	56	+ 11
Electrification ..	11	17	+ 6
Land development[1] ..	..	12	+ 12
Total			+ 185
2. Loss in benefits			
Increased watercourse losses ..	..	4 per annum	— 4 per annum
Use of water for reclamation[2] ..	..	197	— 197
Converted into an annual sum at interest rate of 10 per cent[3] ..	..	20	— 20 per annum
Annual loss in benefits			— 24

However, this example is perhaps rather extreme in that the project is more expensive than most because of the necessity for tile drainage and the need to remove stormwater. But the principle of the argument, if not its magnitude, can be applied to other projects. In most cases an extension of the cultivated area at a low cropping intensity can be undertaken only at an unreasonably high cost to the economy. Priority must first be given to intensifying cultivation on the existing cultivated area. Once this has been achieved, new

1. No significant land development costs would be incurred in the LIP plan, because the whole of the future CCA of 234,000 acres is already under cultivation.

2. With 117,000 acres to be reclaimed, with a total application of 30 acre-feet per acre over three years, total water use for reclamation would be 3.5 MAF. See Appendix 3 for the calculation of the value of the water.

3. An interest rate of 10 per cent per annum is used because this is considered to be the economic value of capital in Pakistan.

land can be developed, but even then it must be cropped at a high intensity if the returns from the investment are to be satisfactory.

5. CONCLUSIONS

The main points to emerge from this study are by no means new, and many other people concerned with irrigation development have reached similar conclusions. One of the main purposes of this paper, however, has been to draw together the factors that influence the economics of reclamation, and to give some measure of the economic value of reclamation and of alternative methods of irrigation development. Although the data used refer to conditions in Sind, the general conclusions and the principles that are outlined should be applicable to Punjab as well.

On the farm scale, reclamation is most unlikely to be attempted unless surplus irrigation water is available. This is because the returns from using water to irrigate crops on areas that are already cultivated are so much higher (approximately Rs. 71 per acre-foot) than those from reclamation (Rs. 15 per acre-foot). When spare water becomes available, reclamation should be profitable for both the farmer and the economy. During the reclamation process, the returns from the rice and berseem crops are more than sufficient to cover any costs involved, while after the process is complete, annual net returns of Rs. 200-500 per acre should be achieved in a perennial area.

On the large scale, when considering the reclamation of large areas of undeveloped land by irrigation and drainage works, the same principles apply. Under the conditions of limited water availability which will apply in Sind for at least the next 20 years, it is far more economic to intensify cultivation on the areas already developed than to extend the cultivated area by a large-scale reclamation. The merits of this argument are clearly demonstrated by the example of the East Nara Tile Drainage Project given in the preceding section. Under present conditions the extension of cultivation into large areas of undeveloped land constitutes a wasteful use of the nation's scarce resources of water and capital.

APPENDIX 1

CROP VALUES

A wheat price of Rs. 12.85 per maund at the farm has been used. This is the weighted average value calculated from the prices prevailing in Sind in the period from 1962 to 1965, and is also in agreement with the import price over the last few years, of about Rs. 13. The present Government support price of Rs. 17 is not likely to be maintained in the future, when production rises and self-sufficiency in wheat is achieved. Furthermore, this price is Rs. 17 at the market, which generally means a price of less than Rs. 15.50 at the farm. Rs. 2 per maund has been added to allow for the value of bhusa (straw), but Re. 1 has been deducted for casual labour costs, giving a net value of Rs. 13.85. Most tenant-farmers in Sind hire labour to help with the wheat harvest, at a normal rate of 1/15th—1/20th of the crop. Seed cotton is valued at Rs. 30.75 per maund, which after deduction of picking labour charges, at about 1/16th of the crop, leaves a net value of approximately Rs. 29.

APPENDIX 2

RECLAMATION WITH PRIVATE TUBEWELL WATER

The average economic cost of water from private tubewells in the fresh groundwater zones of Sind has been calculated as roughly Rs. 24 per acre-foot for diesel wells and Rs. 17 for electric wells. It can safely be assumed that private tubewells would be installed primarily to irrigate existing areas, and that they would supply water for reclamation only if sufficient surplus capacity were available. In this case the cost of tubewell water used for reclamation will comprise only the marginal costs of pumping the additional supplies, rather than the average cost, which includes fixed costs such as depreciation. The only significant item of marginal expenditure will be power, which for diesel tubewells will be Rs. 13 per acre-foot at economic prices and Rs. 20 per acre-foot for the farmer. The difference is due to the fact that economic prices exclude transfer payments such as taxes on diesel oil, because these are not real costs to the economy. Diesel tubewells have been used in this example, since electricity is not available to the farmer in most parts of Sind.

To pump the 30 acre-feet of tubewell water required for the reclamation of one acre of land would require additional expenditure of Rs. 390 at economic prices and Rs. 600 by the farmer. However, during this period the returns from reclamation crops would be about Rs. 450 (see Table 2), so the net cost to the farmer would be only Rs. 150, while in economic terms the crop returns would exceed the pumping costs. Once reclamation was complete, returns of Rs. 200-500 per acre could be obtained. The farmers hould therefore be able to recover his investment in reclamation (Rs. 150) within one year of normal cropping. Although this appears to be a reasonably profitable undertaking, other opportunities for the use of the money, such as the purchase of fertilizers, may give better returns, in which case the reclamation of land by tubewell water would receive low priority. However, from the viewpoint of the economy the costs of tubewell water are much lower and the benefits of such reclamation therefore more apparent.

APPENDIX 3

COSTS AND BENEFITS OF EXTENSIVE DEVELOPMENT IN EAST NARA TILE DRAINAGE PROJECT

1. Changes in Costs

Capital expenditure on tile drains would go up roughly in proportion to the expansion in cultivated area, and would rise from Rs. 312 million to Rs. 468 million. The costs of the disposal drain system would increase by about 25 per cent, from Rs. 45 million to Rs. 56 million, because of the 50 per cent increase in drain capacity required and also the extension of the drainage system. The reduction in drainable surplus per acre resulting from the decrease in cropping intensity would not affect the drain capacity required per acre of land, because this is determined by the stormwater run-off. An expansion of the cultivated area by 50 per cent would result in a 50 per cent rise in the project area's total run-off and thus total drain peak discharge. This would in turn require a corresponding increase in the capacity of the pumps on the Left Bank Outfall Drain, the cost of which would rise from Rs. 14 million to Rs. 21 million. As regards electric power, the network of 11 KV lines, which form most of the electrification cost, would have to be extended. Thus the investment in electrification would go up by Rs. 6 million.

Expenditure on canalization would not alter greatly. The additional 120,000 acres that would be reclaimed is not in one large compact block, but is scattered and interspersed with the existing farm areas. No major extension of the canal system would therefore be needed, although many new watercourses would have to be built. Their cost would be very low and in economic terms would be insignificant, because most of the expenditure would be for unskilled labour which has little or no economic cost.

In addition to all these items, the 117,000 acres of land would itself require development through clearance, levelling, and laying out the field pattern. 39,000 acres is abandoned land, with little bush clearance or levelling required, and this could be undertaken by the farmers themselves at little real cost. However, the remaining 78,000 acres is land that has never been cultivated, which would therefore need extensive clearance and levelling operations. In parts of Gudu Left Bank this cost about Rs. 500 per acre, whereas in one area of Ghulam Muhammad Barrage expenditure was Rs. 300 per acre. To achieve rapid and effective results, tractors and bulldozers would probably be widely used, as they are in Gudu and Ghulam Muhammad Commands at present. It therefore seems unlikely that the average cost per acre would be less than Rs. 150, even when the unskilled labour costs are excluded. The reclamation of this area would thus require additional expenditure of almost Rs. 12 million.

2. Changes in Project Net Benefits

Assuming the same level of water supply from the barrage as in the intensive case the supply available to the project at the watercourse head level would not change very much. This is because canal transmission losses would not increase, owing to the fact that there would be no significant lengthening of the canal system. However, watercourse losses would go up. One could reasonably expect the total length of watercourse to rise by 50 per cent, in the same proportion as the change in cultivated area. In Sind watercourse losses are considered to be about 10 per cent of the volume delivered at watercourse head. A 50 per cent increase in cultivated area would thus mean that an additional 5 per cent of the project area's supply would be lost in watercourses. This would probably reduce total benefits by about the same proportion. The future water supply to the project is planned to be 1.14 million acre-feet (MAF), so an additional 0.06 MAF would be lost in the watercourses. At Rs. 71 per acre-foot (see Table 3) the annual value of this water would be Rs. 4.3 million.

There will also be a substantial loss in benefits through the use of valuable irrigation water to reclaim the extra 117,000 acres of saline and alkali land rather than to intensify on the existing 234,000 acres. Although the value of water will rise considerably in the future, due to yield increases, the existing values shown in Tables 2 and 3 have been used, to avoid confusion. This means in effect that the loss in benefits involved in using water for reclamation is understated. A total of 3.51 MAF will be needed to reclaim 117,000 acres, taking a rate of 30 acre-feet per acre. The economic value of water when used to increase intensities is Rs. 71 per acre-foot, compared with Rs. 15 from reclamation, so for every acre-foot consumed in reclamation a sacrifice in benefits of Rs. 56 is made. On this basis the total loss involved in using 3.51 MAF for reclaiming land is Rs. 197 million.

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