# SCARP Planning in Northern Indus Plains

By

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## SYNOPSIS

Tubewell drainage for control of waterlogging and salinity and use of its effluent to supplement irrigation supplies was initated by Irrigation Department prior to establishment of Water and Power Development Authority. Subsequent studies and SCARP planning guidelines developed by WAPDA placed emphasis on agricultural development with drainage as a by-product. Due to shift in basic objective large number of tubewell irrigation project in fresh ground water areas were implemented. The review of earlier projects to develop future strategy for control of waterlogging and development of agriculture has been examined in the "Revised Action Plan" where the public drainage has been limited only to saline ground water areas. Hither to before comperatively fresh ground water areas were dealt with and the problems in drainage of saline areas were less obvious. Recent experiences in disposal of saline effluent indicate the serious constraint in providing adequate drainage of saline area. Many alternatives are available to reduce quantity and salinity of the effluent, however, none of these is trouble free or less expensive to construct or maintain. There is a need to study the relative merits of direct and indirect drainage modes to arrive at the most appropriate method for providing sub-surface drainage to saline area.

## INTRODUCTION

Irrigation has been practiced from the Indus river and its tributaries since long, and the historic evidence can be traced as far back as the 8th century A.D., when the Arab conquerors differentiated between the irrigated and non-irrigated lands for the purposes of levying land taxes. The later history of the Muslim rule in the Indo-Pakistan sub-continent is replete with descriptions of various artificial canals constructed by the great emperors with the purpose of ameliorating the condition of their subjects and increasing the state revenues.

In the begining, only narrow strips of land along the river banks were irrigated through a large network of inundation canals which could divert water only during high flow season. As the needs of the economy grew, human ingenuity devised ways and means to extend the irrigation facilities to higher lands. In the process of expansion, the irrigation system has been totally transformed and it gradually absorbed all the inundation canals. In the northern Indus Plain, the earliest canal known as "Upper Bari Doab" was constructed in 1859. The last decade of 19th century and the early 20th century witnessed a rapid development of controlled diversions from the Indus river system and included construction of a number of weirs and barrages and extensive canal system to cover the upper and lower Indus Plains. Several link canals to allow the transfer of excess water from one river to another were also constructed to provide

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more flexibility of operation.

With the partitioning of the sub-continent at the time of independence in 1947, the sources of water for many canals serving area in Pakistan came under Indian control. This adversely affected the irrigation of the region. After protracted negotiation between the two countries under the auspices of the World Bank an Indus Water Treaty was signed in 1960 which gave control of 3 eastern rivers to India leaving the western rivers i.e. Indus, Chenab and Jhelum for Pakistan.

Today the irrigation system in the Indus Plain includes two storage reservoirs, 17 barrages, 8 link canals and an extensive conveyance system consisting of main canals, branches, distributaries and minors measuring some 57950 km.

Prior to the canal system the water table was generally in dynamic equilibrium and the depth to water table increased with distance from the rivers. In middle of doabs it was as deep as 30 meters below the natural surface. Soon after the introduction of the canal system, the reports of waterlogging started pouring in and the problem continued spreading with time covering more and more irrigated areas.

The first study to determine the cause was initiated in Punjab as early as 1917 followed by many more studies covering various parts of the canal system and finding probable solutions. In the opinion of various investigators seepage from the canal system which amounted 40 to 47 percent of the discharge at the head was consider as one of the primary causes for the rising water table. These studies also suggested various measures such as construction of surface drainage system, lining of canals, conversion of perennial canals into non-perrenial and lowering of the full supply level of canals. However, the problem of waterlogging was so signficant that these measures did not produce any tangible results. By the year 1947, nearly 5350 km of surface drains were constructed in Punjab alone to remove the surface runoff and thus control the water table. However, due to flat country slope and poor outfall conditions these drains generally silted up and chocked by weeds. Small schemes of tubewell drainage were also initiated. The first tubewell drainage project was undertaken in Rechna and Chaj Doab (Rasul Tubewells) in which these tubewells were constructed along the major canals to intercept seepage water.

In 1949-50 the Government of Pakistan requested the F.A.O. for help in finding solution to the problem. The experts visited, recommended additional investigations to identify the causes and the methods of drainage. They also recommended the investigation to determine the suitability of ground water and utilization of drainage water for irrigation etc. Following these recommendations more F.A.O. experts were sent between the year 1952-54. In persuance of the recommendation made by these experts tubewell drainage was initiated and the effluent was proposed to be used for irrigation. Nearly 256 tubewells were installed by the Punjab Irrigation Department in 5 schemes namely Churhkana, Jaranwala, Pindi Bhattian, Chichoki Mallian, and Shadman.

Pending construction of small tubewells scheme, an F.A.O. expert in his report March 1953 recommended the establishment of a ground water survey division in order to investigate the land and water resources. In persuance of this recommendation "Ground Water Development Organization (GWDO)" was established in Punjab in 1954 with the assistance of U.S. Geological Survey. The investigations carried out by this organization resulted in formulation of the first salinity control and reclamation project, popularly known as SCARP-I covering central Rechna Doab.

In 1958 Government of Pakistan created "Water and Power Development Authority" whose charter included the actions to control waterlogging and salinity in the country. In view of the severity of the problem WAPDA reviewed the SCARP-I report prepared by G.W.D.O. and initiated its construction pending examination of the overall problem in the country.

## THE SCARP PLANNING GUIDELINES

### Background

The President of Pakistan in a meeting in 1961 asked WAPDA to preapre a Master Plan for control of waterlogging and salinity in Pakistan, which was submitted in May, 1961. It divided the irrigated areas in 26 projects, and included construction of 31,000 tubewells, 7,500 miles of major drains and 25,000 miles of supplementary drains at a total cost of 5900 million rupees.

During visit of U.S.A. in July 1961, the President of Pakistan discussed the Master Plan and problem of waterlogging and salinity, threatening the livelihood of millions of cultivators living on the Indus Plains, with the then President of U.S.A. As a result, a Panel of U.S. Experts under Dr. Roger Revelle was constituted to render an expert advice to Pakistan on this problem. While the expert panel was still finalizing its recommendations, in November 1963, an understanding was reached between President of Pakistan and the World Bank President to the effect that the International Bank for Reconstruction and Development (IBRD) would organize a study of the water resources, that would be available to Pakistan after implementation of the Indus Water Treaty (1960), for the optimum exploitation for agricultural and power purposes. The Bank study group engaged "Irrigation and Agricultural Consultant Association" (IACA) a consortium of three consulting engineer firms, to help them in conducting this study popularly known as Indus Special Study (ISS). Whereas, the Panel Report dealt with analysis of more basic issues such as causes, water budget, salt balance and mode-of development etc., the World Bank Report mostly outlined the development programme for economic stand point and other priorities. The major findings, recommendations and guidelines of these two studies related to the subject, are briefly outlined hereafter (2,3).

### Agriculture and its scope

The then status of agricultural development in the country including causes of failures and future scope of its improvement had been dealt at length in these reports and some of the major findings were;

1. "The agricultural output grew at the rate of 1.5 percent per year during 1950-60 and improved sharply during 1960-65, attaining an average growth rate of 3.8 percent; nevertheless the agricultural production per head remained below what it had been fifteen years earlier.

2. The outstanding feature of Pakistan's agriculture is dismally low productivity and is the lowest in the world. So long as its agriculture remains at or below the subsistence level, Pakistan is condemened to increasing poverty. Agriculture is the base of entire economy and its fate is the fate of the entire country.

3. Pakistan's agriculture can undergo a revolution of the kind already occurring in other advanced countries *within a generation.* A rate of increase can be established and maintained which will far outrun the growth of population. With adequate watering and application of fertilizers, it is believed that most of the canal irrigated areas could support an intensity of 150 percent and in some areas more. This can be done by an integrated application of all the factors of agricultural production, combined with sufficient capital investment and sustained human efforts to communicate modern agricultural techniques to the farmers to improve these techniques through research, and to create the economic conditions that will motivate the farmers to help themselves.

4. Waterlogging and salt accumulation are only one of the problems be setting agriculture. *The scanty yield that hold the country side in poverty are not the sequence of any single deficiency.* Waterlogging, salination, water shortage, poor seed stocks, primitive agricultural practices, insect depredations, plant diseases, nitrogen defficiency, fragmentation of land holdings; each of these and many other causes make their due contribution. It is not possible

on a general basis, to identify water or any other single input as being most critical. Rapid progress in one, be it is water or any of the modern productions aids, would only show up more acutely the lack of the others. *Even if all the saline land could be reclaimed and future salination stopped, the resulting increase in agricultural production would fall far short of present and future needs.*

5. The time table for a typical project area, would include a two years preparatory period during which tubewells and drains could be constructed and staff recruited organized; and five years period of intense development during which the target increase in productivity would be 15 percent per year or 100 percent for five years period; followed by growth at a rate of about 7 percent per year indefinitely. If one project was started each year, after 25 years a yield per capital would be above twice the present one even with a population growth rate of 3 percent per year. *Such an ambitious programme will require heroic efforts by the government and people of Pakistan.* This will be a joint programme with the farmers and their cooperation is the central to success.

6. Computation for an illustrative, million acre tract in the northern part of the plain indicate the total gross increase from additional water, fertilizer, plant protection, and existing high yielding plant varieties, even when their effects are computed separately without taking interaction into account, is 157 percent of the presetnt gross value.

**Guidelines for development**

The basic philosophy of agricultural development presented in both the reports aimed at optimum development of surface and groundwater resources to increase the water alongwith other inputs. The Panel Report, though admitted the feasibility of horizontal drainage, yet did not consider it economical and advocated extensive mining of the aquifer and large public tubewell programme. The World Bank recommended development of groundwater to the extent of recharge at 15 feet below ground level and in addition to public tubewell programme, it recommended simultaneous development in the private sector, enlargement of canal in the areas underlain by saline groundwater, surface drainage and pilot tile drainage projects. A brief outline of the priorities and guidelines were as under:

1. In developing of project areas, there should be a strong emphasis on increasing production from lands that have not yet been damaged by waterlogging and salination, side by side with an early attempt to reclaim saline lands. Severely waterlogged area can be left for later development. The past preoccupation of the public tubewell development with the reclamation of the saline and water logged lands should be reduced in favour of the efforts to exploit the groundwater resources for irrigation purposes.

2. From strictly economic point of view, a highest ratio of benefit to cost should be in the northern most sector of the plain, because of low annual evapotranspiration and highest rainfall, requiring compartively less additional water per acre, for intensive agriculture and hence increasing the gross sown area more cheaply.

3. In Punjab, the horizontal drains are not only more expensive than tubewells but they do not provide the outstanding advantage of the latter i.e. the increase and regulation of irrigation water supply.

4. Once the useable groundwater areas needing public tubewells have been covered, then the tubewell construction programme would shift to the saline groundwater areas.

5. Most of the river flows except in a very few months of the year, are already committed, and also the water table has risen to a high level in extensive areas, expecially in some of the

older irrigation areas. The nature of these two problems suggests that the real scope of improving the water supplies by canal remodelling occurs in close coordination with tubewells development.

6. Subsistantial increases can be made in irrigation water supplies in the fresh groundwater zones by means of public tubewells without running into bottlenecks due to lack of development in other facets of water development. Increase of water supplies in the mixing ones and saline zones is a much more complex matter, depending on interdependent enlargement of canal capacity and increased supply of surface water in the rabi season, as well as provision of drainage.

7. In Panel Report during the first level of development, it is assumed that the construction associated with the Indus Water Treaty of 1960 will be carried forward and that large networks of the tubewells will be installed in the Punjab to recapture distribution system leakage and mine the aquifer. This level of development will be reached in perhaps fifteen or twenty years and will use river diversion in amounts not greatly exceeding those or recent past.

8. At the second level, it is assumed that the diversion from the three western rivers will be increased through increasing the amount of surface and groundwater storages for river regulation to the ultimate practical degree of development so as to minimize the amount of fresh water discharge annually to the Arabian Sea.

9. The Bank Study Group suggests groundwater development alongwith canal enlargement and drainage works. In addition it recommends pilot tile drainage projects and considers that tile drainage may subsequently become an important mode of drainage in Saline areas.

10. In acreas where the growth of private tubewell is considerable, public tubewell projects should not be undertaken. Special mention has been made for Bari Doab where the Public Tubewell Projects have only marginal advantages over the alternative to continued private tubewell development.

**Need of Agriculture extension services**

Great significance had been attached in these reports to the agriculture extension service and other corollary development in order to achieve the anticipated benefits as would be clear from the following:

1. "Fundamentally, it is the farmer who will decide whether agricultural production grows at 3 percent or 5 percent and whether per capita provincial income will stagnate or will double in the next twenty years. Only if the farmer has the incentive, the supplies and the knowledge together with confidence and conviction will he produce the results desired. Policy, prices, and market opportunities must be kept under constant review. To achieve higher yields, the farmer needs increased attention from extension services and greatly improved supply channels for various inputs.

2. Only if farming standards are greatly improved before 1975, with the large agricultural benefits anticipated from Tarbela in fact, be realized. Increase of water supplies alone, upon which so much emphasis has been placed in the past, will do no more than extend and prolong the traditional agriculture of low productivity. Technoligical improvement in farming, on the other hand, would with a large enough effort to spread it widely, raise agriculture in Pakistan to an entirely new plan of productivity. Because the application of improved methods depend upon the farmer themselves, it is vital that knowledge of modern agricultural technology, on which the farmers ability ultimately depends, be disseminated within the farming community.

3. Specially important is the transfer of technology to farmers, and the study of techniques of transfer should be given high priority. Three methods seem particularly worthy of further study;

   i) The farm planning or budgeting approach, which has been very successful in the United States and which is the basic technique of intensive programme in India.

   ii) The "Cooperative Academy" approach which has yielded excellent results in Comila in East Pakistan and;

   iii) The use of mass communication media.

4. Success will not occur unless the farmers can be motivated to extend their efforts and to cooperate. Planning goals will remain sterile figures on wall charts.

**Design criteria**

Various design criteria recommended in the Panel Report and partly agreed to be I.B.R.D. were:

1. Not only to recover the recharge, but also to mine the aquifer at the rate of 3.33 feet per year, thereby lowering the water table to 100 feet in 30 years period.

2. The aquifer in the saline area would be mined at 50 percent rate for two reasons;

   a. To lower the water table so as the decrease the hydraulic gradient in the direction of the non-saline area, thereby reducing the hazard of movement of salt;

   b. to provide additional water which can be diluted with canal water and used for agriculture.

3. It is assumed that to provide adequate amount of canal water for dilution of saline tubewell effluent, a somewhat larger proportion of the total available canal flow should be diverted to the saline area than would be supplied on the basis of the relative areas of the two zones.

4. Water mined in accordance with (2 a) and not used in purpose (2 b) would be exported.

5. A portion of the water pumped in the non-saline zone must be exported to prevent an excessive accumulation of salts. It is predicated that at he end of the first level of development, this export flow would be 3.5 Maf/year. During the first decade of development a substantially smaller export flow (0.5 to 1.5 Maf/year) would be needed.

6. The cost studies carried out by the Indus Basin Studies Harvard Water Recources Group, indicate that with the imposed constraints, the relative unit cost of export of saline water is low in relation to the relative unit cost of providing the necessary surface water for dilution through diversion from fresh groundwater areas.

7. The IACA has proposed use of water upto 1000 ppm, without mixing, 1000-2000 ppm after 1:1 mixing, 2000-3000 ppm after 1:2.5 and not to develop water beyond 3000 ppm.

**Implications of proposed development**

The Panel Report recognized certain hydrological implications of the development and recommended certain measures. The report says that there is some indication that highly saline water underlies the

whole of the Indus River basin. When pumping and evaporation of water from the aquifer lasts for any substantial length of time the critical question arises of how the salts concentration of the blended tubewell water and canal water applied to crops will vary in time with any given set of conditions pertaining to (1) the incoming flux of salt in the canal system; (2) salt initially in the groundwater; (3) the salt crust in the soil near the surface of the ground. To answer those questions "Salt Flow Model" for digital computer simulation was developed and investigated. The principal conclusions were:

a. spacing of wells has no effect on the salt build up;

b. rate of salt build up increases in inverse proportion to the well depth;

c. the salinity of irrigation water due to salt initially on the surface of ground increases in inverse proportion to well depth;

d. rate of salt build up increases very nearly in direct proportion to the pumping rate;

e. surface drainage of about 10 percent of tubewell pumping over a 50 year period is needed to preclude eventual salt accumulation in the root zone of the crops. More than 15 percent is unnecessary and less than 5 percent is ineffective. In many cases the pumps to drain flow can be delayed for ten or even twenty years without excessive salt build up provided the total drainage in fifty years is equal to about 10 percent of total pumpage. No drainage condition indicate that high concentrations will be built up after twentyfive years and that this dondition could bo long be tolerated.

### Recommendations

In brief the recommendations of the Panel and World Bank Exports were:

i) Past pre-occupation with the reclamation of the saline and waterlogged lands should be reduced in favour of the groundwater development as a potent sources of irrigation supply.

ii) Greater stress should be laid on agriculture extension service to motivate the farmers, without whom the planning goals would remain sterile figures on wall charts.

iii) Ten percent of the effluent from non-saline zone to be exported to depress the rate of salt build up.

iv) To export the saline water from saline areas fro which surface water is not available for dilution.

v) Unit cost of export of saline water is low in relation to the relative unit cost of providing the necessary surface water for dilution through diversion from fresh groundwater areas.

## EALIER PLANNING STRATEGY

### General

In the light of the observations of the experts already summarized, it would be worth while also to examine the planning strategy adopted in the "Regional Plan for Northern Indus Plain", prepared by Tipton and Kalmbach Inc., WAPDA Consultants on Reclamation Projects, for Punjab.

Removal of water logging requires draining the soils of excess water while the remedial measures for salinity/alkalinity needs, in addition to efficient drainage and the other ammendments, more water for

leaching the soils. The inadequacy of irrigation supplies to sustain even the existing cropping pattern and intensities at that time can be well understood by the following (4):

> "During the base reference period (Rabi 1959 through Kharif 1961) 17.6 Ma. were cropped annually in the reclamation area of 20.8 Ma giving an annual cropping intensity of 85 percent. An approximately 10 percent of the land was double cropped, only 75 percent of culturable land was actually farmed and 25 percent lay fallow.
>
> Of the 17.6 Ma cropped, 16.4 Ma were irrigated with canal supplies, and about 0.5 Ma were irrigated with groundwater from tubewells and persian wheel wells. In addition 0.7 Ma within canal commanded area were cultivated as Barani land. The critical inadequacy of irrigation water supplies in relation to the area being farmed is evident from the fact that even the relatively meodest water requirements of the traditional cropping patterns and intensities were not being satisfied. The full annual water requirement for the crop acreages and cropping patterns is estimated to be 43.8 Maf at the head of the watercourses. Canal supplies and supplemental pumpage average 32.8 Maf but the shortfall was greater than the difference between supplies and requirements. Thus even at the very low cropping intensity of 85 percent, the annual irrigation water shortage for the region was 14.4 Maf, which comprises 3.67 Maf in Kharif and 10.8 Maf in Rabi. Rabi shortage for the various canals commanded areas range from nil to more than 80 percent of the requirements and average 49 percent. Kharif shortages range from nil to 55 percent and average 16 percent. Between 1960-65 mean annual irrigation supplies increased by about 6.30 Maf owing to public and private tubewells development. However, as the cropping intensity also increased from 85 to 92 percent, only 7.3 Maf of additional supplies were useful in relieving the base shortage of 14.4 Maf".

**Planning strategy**

In view of inadequate irrigation water available, it was desired to provide drainage through exploitation of the groundwater reservoir and use the effluent after mixing it with canal water, for leaching the soils and meeting the optimum crop water requirements. The emphasis, however, shifted from drainage and Reclamation to extensive Agricultural Development, probably, with a view to make the projects look economically feasible and financially more viable as would be clear from the following(4):

> "Prior to about 1950, West Pakistan was self sufficient in grains. By 1965 the annual value of grain imports had increased to Rs. 600/- million despite the rise in production between year 1960-65. If this trend were to continue, the value of grain imports would rise to about Rs. 2000 million annually by 1985. As accumulated grain surpluses in U.S.A. are practically exhausted most of wheat requirements, if available at all, will have to be purchased on the open market with disastrous effects on the Pakistan's economy. This kind of situation cannot be tolerated in the economy of an agrarian nation, and development planning must concentrate on the elimination of the potentian food deficits. However, to stress only the shortfall in production of food overlooks the more fundamental effects of the failure of agriculture. Obviously, to sustain a viable economy an agrarian nation must do more than just to meet its internal requirements. Therefore, the real measure of the agricultural problem is economic gap between actual production which could realistically be expected with reasonable development of available resources. The economic gap includes both the food gap and the wealth which has been and is being lost by the failure of agricultural sector to produce exportable surplus for the world market".
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> The planning strategy, therefore, provided for two stages of development for Indus Plains:
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> "The first stage invloves more or less, maximum development of the land resources by the most expeditious and economic means and exploiting to the utmost of all existing facilities and works. It includes the full exploitation of the groundwater resources of the region coupled with optimum use of the existing surface storage and distribution facilities including the IBP works. Average

cropping intensity of 150 percent can be attained in the areas where the groundwater is of acceptable quality for use as irrigation supply. These areas comprise about 80 percent of the region and are presently cropped at an under water intensity of about 85 percent. Moreover, in conjunction with redistribution of season canal water supplies and more effective use of the capacities of existing surface water and distribution works, the groundwater development will provide significant supplemental supplies to 3.6 Ma of land which are underlain by saline groundwater. The objectives of the programme is to foment rapid growth agriculture to close the gap in production and demand, and to impart sufficient momentum to the economy to over-ride minor restraints.

With the completion of the construction programme is 1980, physical development of the culturable area will be essentially complete, many features of relatively modern technology will be incorporated in most farm operations, agricultural will be producing exportable surpluses, and other sectors of the economy will be experiencing rapid growth towards economic parity with agriculture. The second stage of development will chiefly involve consolidation of the physical irrigation plan for sustained long term growth based on advance in technology, rather than an increased intensity of cultivation. Physical development will comprise surface storage and distribution works and drainage facilities to relieve the problems associated with the accelerated development and to bring upto full development, the saline zones which cannot be served directly by tubewell projects. The essential feature of the future programme is the Indus Plain Reservoir which will provide 20 Maf of off channel storage for Indus River runoff. In conjunction with new cross link extending Irom Kalabagh to central Rechna, Doab, and appropriate remodelling of Balloki Sulemanki link and of the canal system serving Lower Rechna Doab and Lower Chaj Doabs, the Indus Plain Reservoir will provide a final solution to the problem of irrigation water supply to the Northern Indus Plain".

**Water quality standards**

In view of shifting emphasis from reclamation to development for which more water was required, and to avoid immediate complications in disposal of saline effluent rather liberal water quality standards were provided (4):

"The programme may involve local or temporary overdevelopment of groundwater and appropriate compromises of standards of irrigation requirements and quality of water, and any other measures which will accelerate development. The level of groundwater development proposed in the Regional Plan is determined by the irrigation water requirement and by the availability of groundwater rather than by conservation criteria. It is proposed that withdrawals from a given area, or from the region as a whole have not been limited by balanced recharge discharge concepts, or by any criteria which involve hydrologic equilibrium as a limiting condition".

"The groundwater containing less than 1500 ppm dissolved solids is classified as non-saline and safe for use under accepted irrigation and water management practices by which it is implied that about 1/3rd of applied irrigation water is derived from canal supplies. Groundwater containing 1500 to 4000 ppm of dissolved solids is classified as intermediate; use of intermediate quality groundwater will require dilution with canal supplies, or special water and soil management practices. Water with concentration of more than 4000 ppm of dissolved solids is unsuitable for economic development for irrigation supplies under the present and assumed future conditions".

The irrigation water quality and the quality of groundwater recommended for exploitation and use in various projects planned sofar is given in the following Table.

Table Recommended irrigation water quality and ground water quality

| Name of Project | Irrigation water quality | | | Groundwater quality | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Marginal | 1:1 mix. | | Hazardous** | | |
| | PPM | SAR | RSC | PPM | SAR | RSC | PPM | SAR | RSC |
| SCARP-I | 1500 | 15 | N.S | >1500 | →15 | – | – | – | – |
| SCARP-II | 1100 | N.S | N.S. | – | – | – | – | – | – |
| SCARP-III | 1000 | 10 | 1.25 | 1000)<br>2000) | 10)<br>20) | 1.25)<br>2.5 ) | >3000 | >20 | →2.5 |
| SCARP-IV | 1000 | 5 | 1.25 | 1000)<br>2000 | 5-10 | 1.25<br>2.5 | >2000 | → 10 | →2.5 |
| SCARP-V* | 1500 | 5 | + | 1500)<br>2500) | 5-12 | + | →2500 | →12 | |
| SCARP-VI* | 1500 | 15 | – | – | – | – | – | – | – |
| SCARP-VII* | 1500 | 5 | 1.25 | 1500)<br>2500) | 5-13 | 1.25)<br>2.5 ) | >2500 | >13 | →2.5 |
| Regional Plan | 1500 | 10 | + | 1500)<br>4000) | 10-25 | + | >4000 | →25 | + |

*Projects not implemented so far and are being revised.

+bicarbonate hazard not recognized (p–11) Vol.III.

**not to be exploited; N.S. not specified.

"According to the available data for quality of water, the salinity of soil solution will not be a limited factor on production. In these areas where drainage relief is indispensible to further development and the groundwater is saline, as in parts of Panjnad Abbasia, Lower Jhelum and Muzaffargarh canal commands, the plan includes the basic drainage works that will be required for the disposal of saline wastes. In this connection it is pertinent to re-emphasize that subsurface drainage does not necessarily imply lowering of the water table to a specific depth. Hazardous drainage conditions are assumed to occur where water table is within 10 feet of land surface. Moreover, this classification derive more from the pattern of groundwater movement than from the proximity of the water table. Under the existing water management conditions and hydrologic envoirnments, the area where the water table is about 10 feet of land surface funciton for practical purposes as sumps, discharging groundwater to the atmosphere through evaporation and transpiration and leaving damage residue of salt at land surface. The drainage hazards in these area can be eliminated by reversing the pattern of circulation, thus converting the areas essentially to zones of groundwater recharge".

**Implications recognized**

Due to the proposed extensive development of groundwater the prospects of salt built up due to recirculation and contamination by migration of saline water was examined and it was concluded (4):

"There remains the matter of regional effect of development on the quality of groundwater. In this kind of system water containing salts in solution is imported to the irrigated areas. The water is exported as evaporation and transpiration but most of the salts remain, Obviously there must be built up of salts somewhere in the system presumably these salts must ultimately be extracted before they reach intolerable levels of concentration in the recirculating groundwater. However,

the increase in salinity of groundwater will be very gradual. The canal supplies, which are the source of the salts, are weakly mineralized and the effects of concentration by evapotranspiration processes are mitigated by dilution with other components of groundwater recharge i.e. seepage from canals and rivers and precipitation. Another aspect of salt balance is the hazard of contamination of the fresh groundwater zones by migration of water from the saline zones. Drainage benefits in saline zone are major by-product of groundwater development in the non-saline and intermediate zone. The resulting pattern of groundwater movement will inevitably cause lateral movement of saline water, but at rates measured in terms of feet per year, possibly at depths below the non-saline zone. Moreover, intermediate zone will form a buffer which will protect the non-saline zones from contamination for several decades of operation. It is clear, however, that change in quality, if any, occur very slowly, and they may not be measurable over a period of several decades. *In summary, whereas it is clear that provisions must ultimately be made for a regional network of drainage tubewells and surface drains to control accumulation and distribution of saline residue to protect the quality of groundwater supplies, it is equally clear that this is not a matter of immediate concern which will require action during the period of the development plan described herein.* In fact, there are sound technical and economic reason to defer consideration of Regional Drainage facilities. From the technical stand point, the nature of the works which will be required is apparent, but the magnitude and staging of the work will be determined by the pace of development and by the resulting hydrologic response of the groundwater reservoir. Until some definite trends are identified, it will not be feasible to undertake the programme of regional drainage. These kinds of works are defensive in nautre and do not contribute directly to development. As development is the immediate and critical objective of the SCARP programme, there should be no dilution of the development funds until the essential objectives are realized. Accordingly, it is concluded that consideration of regional drainage works to control groundwater salts balance would be premature at this stage of the development programme".

**Summary of approach**

The liberal standards of water quality were prescribed under the pretext that with good water management conditions and provision of adequate leaching, these waters can be used without detriment. The optimum crop water requirement is assumed to provide 14 percent of water for leaching which for most soils in Punjab, is considered enough to maintain ECdw at value not in excess of 8. m.mhos/cm.

The basic approach to the problem followed hitherto before can, therefore, be summarized as under:

1) To remove chronic shortage of irrigation water;

2) Planning must concentrate on the elimination of potential food deficit;

3) To forment rapid growth of agriculture and impart sufficient momentum to the economy to over-ride minor restraints;

4) Over development of groundwater, if necessary, to meet the crop water requirement and appropriate compromises of standards of irrigation requirements and quality of water and any other measures which will accelerate development;

5) The problem of built up of salt within the system through recirculation and need to extract it before it reaches intolerable levels recognized. However, as these works are defensive in nature their implementation not recommended in first stage to avoid dilution of development funds; and

6) Cropping intensity to be increased to 150 percent.

After examining the operation of SCARP-I, the Provincial Government restricted the lowering of water table only to 15 feet below natural surface, in line with I.B.R.D. recommendations, and to follow the irrigation water quality standards laid in U.S. Agriculture Hank Book 60.

## PRESENT APPROACH

On recommendation of the World Bank appraisal missions regarding need to revise and up date the Indus special studies (1967) the Governemnt of Pakistan initiated a study to draw the future strategy and action plan to guide the policies of the govt; in the agriculture and Water sector. The study was carried out during 1976-79. Among other things, two major guidelines are available for the Scarp Planning: (5)

a) To maximize output growth in short run through high return investments early in the period i.e. emphasis on agriculture and water management and focuss of small farm target group are required.

b) Development for all useable groundwater areas be left to the private sector and financed by suppervised credit.

In the present approach in Scarp Planning, the project areas therefore, became limited to saline groundwater. The on farm water management is being introduced as a component of the projects under planning, subject to the limits of studies and research available.

The concept of large size projects has also been given up to facilitate the implementation and overcome financial constraints. This policy also helps in quick implementation and operation of projects to have early return on the investment.

### Drainage mode

The project areas are now limited mostly to saline groundwater which cannot be used even after mixing. The satisfactory disposal of saline drainable surplus is causing a serious constraints as the rivers and canals cannot accept all of it. In order to overcome this situation various alternatives available are:

a) Disposal through "National Drainage Net-Work" to the sea.

b) Disposal into the evaporation reservoirs.

c) Skim the less saline groundwater through pumped tile drains and dispose off into canals/rivers/national drainage net-work.

d) Reduction in seepage through lining of minors/distributaries and ultimately branch and main canals.

e) Intercept major portion of seepage from main canals/branches through brurried intercepting pumped tile drains.

Each of the above alternative is neither trouble free nor less expensive to construct and maintain. Applied research and field studies are required to exactly determine their relative merits and associate problems.

Water Management

One of the emphasis in Revised Action Plan is on water management which may include the impro-ment of:

a) Efficiency of water delivery system from rivers to outlet head (Government owned channels).

b) Efficiency of water delivery system from outlet to sanctioned Nakka (i.e. sanctioned watercourses the joint property of farmers).

c) Efficiency of farmer's own channels to carry water from sanctioned Nakka to farm Nakka.

d) Efficiency of water application through precision land levelling to assure uniform application of water.

All of the above improvements, none of which is less important, aims towards increasing water to the crop through water conservation. Earlier, water to the crop was increased through generating more water through tubewells and now "new water" is generated through conservation. Therefore, unless other associated measures of production increase such as; seeds, fertilizer, pesticides, and cultural practices etc., are not integrated with water management then its impact cannot be anticipated much different from the earlier. However, in order to integrate these things effectively, (because these already exist) micro-level studies are invitable. Though one such effort is being made by Wapda through initiating the planning of "Command Water Management" Pilot projects for various provinces, yet more needs to be done by the applied research institutes dealing with water and agriculture.

**Conclusions**

1. Earlier SCARP planning strategy was based on intensification of agriculture and obtain drainage as a by-product. The first stage development was therefore, limited to fresh groundwater areas.

2. Reiew of first stage development during 1976-79 resulted in revised SCARP planning strategy which limited the public drainage only to saline ground water areas. It also provided for transition of SCARPS in fresh ground water area to the private sector and laid emphasis an water management.

3. Effective land drainage of saline ground water zones is constrained due to disposal problems of the saline effluent. Various direct and indirect modes of drainage are available, none of which is either trouble free of less expensive. Urgent studies are required to select the appropriate drainage mode for saline ground water areas.

4. Water management is presently limited to water conservation methods thereby increasing the water supply at the farm gate. The action is similar to earlier SCARPS where water supply was increased through generation of additional water from ground water reservoir.

5. If water management is not supported by non-water inputs and adequate agricultural services, the results may not be much different from those obtained from already operating SCARPS.

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