# Research on Water and Land for Survival

*By*

DR. NAZIR AHMAD*

## NATURAL BOUNTIES FOR WEST PAKISTAN

Very few countries of the world are gifted with such vast natural resources of water and land as the West Pakistan. The perennial water flow of the Indus and its tributaries, ranks among the most extensive and important resources of the world. The country is also gifted with vast tracks of the most fertile culturable lands. These are the two bounties of nature for the dwellers of this region to utilize them to their fullest advantages. It was only less than a century ago when a start was made to use these resources scientifically. Before the development of Irrigation system out of 164.5 million acre feet of annual flow of the rivers only a fraction was spread on the land during flood season and this natural irrigation was used for the production of food and fibres[1]. Only thin strips of land around the rivers were thus utilized. The control of the rivers was started in 1834, the first canal—the U.B.D.C., started to flow in 1872 in the Punjab plains of the West Pakistan. Slowly almost all the easily accessible water resources were utilized. By 1960, out of 142 million acre feet of water of the three rivers available to West Pakistan, 62 million acre feet were being utilized and 80 million acre feet got wasted into the sea. The Indus plains possess 62 million acres of culturable areas. Out of these only 32 million acres receive irrigation and 25 million acres are cropped at a time. Large tracts of land are still lying unutilized for want of water.

## COUNTRY FACES PROBLEMS OF WATER AND LAND

With the diversion of the water resources to the land, problems of irrigated soils started to take shape, insignificant in the beginning and now Problem Number One for the country. By 1920 these problems had undertaken a menacing magnitude. The country was forced by circumstances to find their solution, it was forced to create an Irrigation Research Institute. Thus came into being the present Irrigation Research Organization in 1924 and which

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*Principal Research Officer (Physics and Soil Mechanics), Irrigation Research Institute, Lahore.

during the next seven years continued to take shape under the slow and cautious machinery of the Government. By 1931 Mckenzie Taylor was posted as the Director who collected several scientists of repute. This group started to solve problems of the country and very soon its contributions became famous not only in this country but in the whole world. In this article the writer who has been associated with the functioning of the Institute for the last 32 years, has briefly reviewed the past achievements, with respect to some problems of soil and water, their future scope and has stressed some deficiencies to fully exploit these natural resources.

## TUBEWELLS TO EXPLOIT THE GROUNDWATER RESOURCES

In 1936-37, the Irrigation Department undertook utilization of groundwater for Irrigation of land. Mr. Montague was appointed to conduct a study on the feasibility of the use of groundwater for this purpose. At that time little information was available on the hydraulics of tubewells. The Research Institute had just undertaken a study of the physical properties of the formation with respect to underground flow. Apparatus and techniques for the determination of permeability coefficient, and the gradation of sand particles had just been perfected. Mr. Montague entrusted the Institute to clarify, by model experiments the effects of many parameters, like depression head, length of strainer, diameter of strainer, size of shrouding, limiting velocities etc., on the yield of a tubewell. This was the beginning of research on tubewell hydraulic in the Research Institute[2].

In 1944-45 Mr. Haigh, the then Chief Engineer of the Irrigation Department embarked upon installation of 1800 tubewells in Rechna and Chaj Doabs. He planned the installation of tubewells in groups and also close to canal at 60 ft. from its bank. On his initiative, studies on interference of multiple wells and the estimate of contributions from a canal to a tubewell located close by, were started. The Institute supplied answers to his queries. Operation of about 1342 tubewells of this scheme was started in 1954 and within a few years, problems of deterioration of tubewells, fall in their discharges, increase of pumping levels, changes in groundwater levels and its quality and other performance characteristics started to appear. The Irrigation Research Institute contributed to the causes of incrustation and corrosion of tubewell strainers. It studied the performance of different types of strainers, clarified the conceptions of deep and shallow tubewells, multiple well system and such other aspects of hydraulics of tubewells and the yield of the formation of the Indus alluvium. During the last eighteen years, since independence, nearly 84 technical reports and research publications on tubewell design its hydraulic

and allied problems have been issued. These contributions have advanced the knowledge of tubewell hydraulics considerably.

A new use of a group of tubewell was demonstrated for dewatering deep foundations. This technique was found convenient and alluring so that it completely changed the old sump method of construction under water. Its care free performance was established while dewatering Chichoki Mallian Hydro-electric Station,[3] Ravi Syphon, Panjnad Headwarks, Guddu Barrage and Gujranwala Hydel etc.

The idea of multiple strainers[4] to work a tubewell at its maximum efficiency, to obtain the maximum yield for the power input and a means of increased durability of performance has originated from the Institute.

For the last two decades, the Research Institute has continued to explore and solve problems of economical utilization of groundwater. At present the research is directed to understanding the causes of incrustation of strainers, fall in their yield with time and have advocated measures to remove the incrustation and to prolong the life of a tubewell.

Investigation of Cathodic Protection technique[5] for use on tubewells and tests on cheap and inert materials like plastics, cement asbestos, and baked clay to prolong the period of incrustation and to renovate the incrusted wells are some new lines of tests.

The deeper one probes into a tubewell hydraulics, the more complicated problems one has to face. The withdrawal of water from various regions of a well screen, the effectiveness of a nonpenetrating well to skim the good quality water from above a saline water, intermixing of good quality and saline quality waters, deterioration of ground water qualities as a result of pumping, are a few problems yet awaiting understanding.

## GROUNDWATER

Groundwater is a precious mineral which has accumulated in the vast reservoir of the Indus formations during the last several centuries. With the development of irrigation system, its accumulation increased at a rapid rate. The Research Institute has studied, the rate and the origin of the accumulation of the good quality water over saline groundwater[6]. Attempts have been made to clarify the origin of the existence of saline groundwater in the central regions of the Doabs and the reasons for the existence of fresh water in the Indus plains. The idea of limited and insignificant sub-soil flow, blocked by the presence and existence of clay deposits of the Indus alluvium and a cause for the existence of pockets of saline groundwater, originated from the Institute[7]. Determination of sub-soil flow volocities, their direction by the use of modern technique of Radio Isotopes[8] and salt methods are promising.

In addition to the problem of groundwater investigated so far in the Research Institute, new problems like:

(*i*) the changes in the movement of sub-soil water as a result of its large-scale exploitation.

(*ii*) intermixing of saline with good quality water.

(*iii*) after intensive pumping, decline in levels of groundwater and its exhaustion, are immediate problems for investigation.

(*iv*) Research has to find ways and means to recharge the exhausted source of water. This reservoir in the Indus formation shall have to be kept charged with fresh water for use wherever and whenever one needs.

## SOIL PHYSICS

A section for soil physics was the first to be established at the time of the organization of the Irrigation Research Institute in 1931. The problems investigated in the earlier stages were the capillary flow and the development of potential forces in an unsaturated soil. The estimation of the permeability coefficient and the gradation characteristics together with atmospheric changes causing fluctuations of groundwater levels were some lines of investigation. These were mainly laboratory studies. The systematic investigation of soil physics problems, however, started with the establishment of the Field Research Station at Niazbeg in 1959. The studies pertaining to water conservation and its utilization have given results of national importance.

### (*i*) Water lost from soil

Till recently there was no clear idea about the amount of water lost from a soil medium under different conditions and positions of watertable. This study was undertaken at the field station and it gave most informative and useful results[9]. It is now possible to give an estimate of water lost from the Indus plains when the soil is kept fallow and the watertable exists at different depths below surface.

### (*ii*) Water lost by evaporation

Evaporation from soil had to be related with evaporation from free water surface. This information was essential as the country had limited sources of water and many storages and reservoirs were coming up. The studies were started at Niazbeg and it was soon found that the information could be extended to the whole of West Pakistan. Free water surface evaporation contours have since been plotted for the West Pakistan[10]. An estimate of the amount of water lost from a reservoir constructed or proposed at any site in the country is now available.

**(*iii*) Water conservation by reducing evaporation**

An obvious piece of research was, the development of methods to conserve water and to adopt means to reduce the evaporation loss. Though in other parts of the world chemical and physical measures are being adopted but in our country we have little experience on the use of various materials. It was necessary to have some basic information on the effectiveness of the locally available materials. Preliminary studies have shown that it is possible to save 30 to 60% of water being lost as evaporation by the use of wax turpentine emulsion, cotton seed or linseed oil etc. A beginning has been made on the use of these types of materials.

**(*iv*) Sub-irrigation as a source of water for crops**

At many places in the irrigated areas of West Pakistan we have high watertable. It is useful and harmful at the same time. Its usefulness lies in providing a certain amount of the water requirements of the crops from the soil moisture. It is termed as sub-irrigation. With this source of water fulfilling partly the requirement of a crop, the surface irrigation, its intensity, and frequency is reduced. An estimate of the amount of water consumed from soil moisture by various crops under different conditions of soil and water is thus available.

There is little information on the drainage surplus as influenced by the position of groundwater levels, the nature of soil and the intensity of Irrigation. Studies were thus started at Niazbeg to obtain this type of information. Experiments conducted with sugarcane, cotton, wheat and gram with different positions of watertable have given the order of sub-irrigation and the component of amount of drainage surplus.

**(*v*) Water wasted by Evapo-transpiration**

Plants must transpire water to build up their tissues but under certain conditions when more moisture is available as a result of high watertable, they transpire more water to keep up their existence. This causes wastage of water. High watertable is harmful for some crops like cotton and beneficial for others like sugarcane. To conserve water and to reduce wastage and at the same time to utilize the sub-irrigation fully, a knowledge of the amount of water lost as evapo-transpiration by different crops grown in different soils, under various positions of watertable, was most essential. These studies undertaken at Niazbeg Field Station have yielded very informative and useful results[12]. Now it is possible to plan for an optimum depth of watertable to conserve water being lost wastefully without effecting the yield.

**(*vi*) Soil Temperature**

One of the physical parameters besides the capillary forces which effect the movement of soil moisture and accumulation of soil salts, is the temperature variation of soil which is effected by variation of seasons. An information on this paramter as effected with changes of air temperature and the variation in depth of watertable is useful to understand movement of soil moisture and salts. The Institute had developed electrical thermometers[13] which are used in soil to record its temperature and thus to understand the movement of moisture and salts under temperature gradient.

**(*vii*) Determination of Blaney Criddle Coefficients for West Pakistan**

During water dispute with India, it was noted that in West Pakistan, information on water requirements of crops was insufficient. This estimate had thus to be based upon Blaney Criddle Coefficients. Unfortunately these coefficients had not been determined for the conditions of our country. The meteorological data were available but such factors as the nature of soil and the position of ground-watertable, were factors unaccounted for in the formulae of Blaney and Criddle. The position of watertable and nature of soil caused a considerable variation in the estimate of the water requirements. The Research Institute is now determining, these coefficients for common crops of the country as effected by various parameters.

## SEEPAGE ESTIMATION

Although the country has extensive system of irrigation canals, majority of which are earthen canals dug in soil but the information on losses particularly with regards to seepage from rivers, canals, branches, minors, water courses and fields, still needs an organized and a systematic study. Some estimates based upon experience of engineers for the area and field of his studies have been made, but the problem needs more concentrated efforts. The Research Workers of the Institute have devised several new methods. The use of electrodes and salt methods, recording changes in groundwater levels, using seepage meter, current meters, sharp crusted weir, meter flume and several other devices has been made but the estimate of water lost as percolation from various canals is still only approximate. It will now become all the more important with the fall in groundwater. It is still to be determined whether the use of surface water or that percolated and then repumped will be more economical.

## CANAL LINING TO CONSERVE WATER

Lining of canals has always been advocated as a measure against water-logging and wastage of water.

In 1944 the Irrigation Research Institute, started investigations on materials for lining of new canals. The relative performance of double tile, single tile lining with impregnation of different thicknesses of plaster, use of bituminous layers, bituminous sand mastic, drainge behind lining, were a few of the investigation conducted in the Research Institute. The unlined earthen operating canals have ever remained a problem. Recently active studies have been undertaken to develop some sealants[14] which when added to an operating canal will reduce its seepage. These studies appear to be very promising. It is hoped to find a suitable type of material which when added to an operating earthen canal will reduce its percolation.

## RESEARCH ON TILE DRAINS

So far we have stressed the importance of drainage of land by short-lived costly tubewells. We have not yet carried out any study with tile drains which are a proven means of drainage in other countries of the world. There is a vast field of investigation with regard to the working of tiles, their method of laying, their depth, spacing, estimation of drainage surplus and host of other problems. There are several areas in West Pakistan particularly in the delta and the Sind where utilization of this system of drainage will be necessary. Investigations on this item on the scale needed for the country have not yet been undertaken.

## WHAT IS LACKING IN OUR RESEARCH ORGANIZATION

When the Irrigation Research Institute was to be established, expert advice from Dr. Keen and Dr. Russell of Rothamsted Experimental Station, in England was sought. At that time the problems of the country were not so immense and so serious. In the years 1922—1924 the country was faced with after effects of war. There were limited resources and funds available were scarce, so that one had to be modest with a research organization. Many of the important sections essential for proper understanding of soil and water research were left in abeyance. Only seven sections of research, on soil chemistry, soil physics, physical and agricultural chemistry, land reclamation, statistics, mathematics and hydraulics were set up although at that very time Rothamsted Institute had many more sections.

Now after forty-four years, the problems of soil and water have multiplied. These problems of land and water had become enemy number one of Pakistan. Unfortunately the set up proposed 44 years ago does not exist even now. Drainage of land is foremost. There is no expert working on the subject. The biological changes in soil are important but there is no bio-chemist for

these studies. Much is being talked about development of plants resistant to salinity but there is no plant physiologist. There is no ecologist, no bacteriologist and so on.

The Irrigation Research Institute and the department of Land Reclamation suffers seriously from lack of trained, qualified personnel. There are no experts in the country and no attempt has yet been made to rectify this defficiency. The Research Institute lacks considerably the availability of funds and facilities. The model of the research organization like, Rothamsted Experiment Station in England, River Side Research Laboratory of America, Agricultural Chemistry and Soil Chemistry Research of Hungary, and innumerable such Institutions in Russia, France, Italy are available to us. Unfortunately during all these years although talking loudly about problems of land and water, we have created no facilities to train Scientists in Soil and even in the subject of Irrigation. If we have to survive we must be in a position to solve our problems ourselves. This is only possible by strengthening the research organization of the country.

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