Proposal for Establishing A Field Drainage Experimental Farm

By

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WATER logging has become on increasing menace in West Pakistan. It is reported that teach year we are losing about 50,000 acres of land due to water logging. In order to save this land from being lost it is essential to provide adequate drainage system.

The drainage projects will cover three phases:-

a) The drainage of the fields under cultivation.
b) Disposal of the water drained from the fields to a suitable point.
c) The drainage of the water carrying canals etc.

It is only first phase that we will discuss here, since no attention has ever been given to this phase while planning for drainage.

The drainage of irrigated lands again differs from drainage of wet lands in general as the former is usually connected with arid zones and later with humid zones. The methods of field drainage of irrigated and humid tracts are so different, both in principle and practice, that it is necessary to throw some light on both the systems so that there is no mis-understanding.

Drainage of Humid Zones:

In areas where, there is excess rainfall, the land is sometimes so wet that it is in swampy condition and cannot sustain any growth due to too much moisture in the soil and improper aeration. Permeability of soil is also too poor to allow the water to percolate at reasonable rate to reduce the moisture contents and healthy aeration. There is usually a hard pan at a depth of a few feet which prevents percolation of water downwards. Clay particles in such soils are extremely minute and fine and caliber of pore paces is so small that the rate of percolation of water through it is negligible. They are colloidal in nature and when they absorb moisture, the mass swells enormously and becomes tightly packed and impermeable. The water table in such soils is not high. The water requiring drainage does not contain many injurious salts, If water table is high the water usually does not have any pressure and there is less danger of water rising up due to pressure of capillary action. In such soils again, since the source of water is usually at the top, the drains are shallow. If deep drains are provided those will be such soils. Water logging can also occur in lighter soils and sandy soils of humid areas when there is an impermeable layer down below and soil conditions are such that there is no lateral movement component like calcium phosphate, nitrates., Sulphates etc, and the presence of such soil if drained will tend to lose these components becomes necessary for proper cultivation.

The source of water causing water logging is rain fater which may come form run off, seepage from higher lands or seepage from natural streams etc. This is particularly true in case of narrow and steep valleys. For the best crops productions, the water table has to be at least 3 to 4 ft. deep, and drainage in such areas is limited by adopting such methods whereby water tables is kept below 3 to 4 ft, from the surface. The usual methods of drainage in such areas are;-

1) Mole drainage by means of a mole plough or mole-ball and pan breaker, pulled behind a crawler tractor. The mole-ball leaves behind circular holes at depth of about 24 to 30 inches and 9 ft. to 12 ft. apart which acts as a drain;

2) Tile drainage which consists of building tile drains usually at a depth of 3 to 4 ft. and 30 to 40 yards apart. The depth of in case of tile drainage varies greatly from 1 ½ ft. to 6 ft. and so the distance, which varies between 40 yards to 100 yards

3) Open ditch drainage which consists of open ditches usually 2 ½ to 4 ft. deep and spacing 100 ft. or so. This method however is getting very unpopular as it is difficult to keep ditches clean, free from weeds, and as ditches have usually tendency to form impermeable deposits at the slopes and the bottom, the maintenance of open ditches is also very costly.

4) In addition there are a number of other methods though not very important like vertical drainage which consists of draining the water into sand layer down below by constructing, a vertical drain with he help of drilling rig or augers; pole drain brush drain, rock and cobble drain.

These four methods usually consist of construction, of ditches and filling them with poles, brush, stones and cobble etc. which water can flow. These methods have proved to be uneconomical in the long run and are obsolete now.

Drainage of Irrigation Zones

This is the type of drainage with which we are concerned most in West Pakistan. This type of drainage is undertaken with two purposes:-

(i) To protect from injury the lands which have been reclaimed from their natural state at considerable expense and have been productive.

(ii) To reclaim lands which have been already injured and cannot sustain even a blade of grass. These lands ordinarily were as good as lands mentioned under (i) above.

The cause of water logging in the irrigated areas are the following:-

(a) Frequently the lands suffering from water logging are not those to which irrigation water is supplied but rather those which are low lying and are injured by seepage from higher lands.

(b) The lands lying near the unlined canals which carry water at a high head and water seeps from the banks and sides and completely water-logs the lands.

(c) The irrigation water is lost by deep per-collation which brings the water table up and when it reaches around the plant roots, it may remain there for a dangerously long time.

(d) The seepage water from the above three sources has lateral movement and has high pressure working upwards and at suitable places water due to pressure and capillary action rises and comes very close to the ground surface, thereby making the land unfit for cultivation.

There is usually no hard pan down below as in case of humid areas. Water reaching he ground surface evaporates leaving soluble salts behind. The salt accumulation increases at the surface, and reaches a limit which is beyond plant toleration and plants do not grow. The will clearly shows that the drainage problem of irrigated tract will be altogether different from that of humid tract as the causes of water logging in the two cases are completely different. The effects of water logging on the lands in the two cases therefore are sometimes similar and sometimes different.

Advantages of Drainage of Water Logged areas:

Following are the advantages:-

(i) The excess water is drained from the land and therefore air can circulate in the soil creating proper balance. Air is essential for root development of the plants.

(ii) In water logged soils, organic matter decays, giving rise to gases and substances which are injurious to plants, which is avoided by drainage.

(iii) Drainage keeps the soil warm and thereby helps early germination.

(iv) Under proper drainage conditions, plowing and other operations become easy

(v) Texture of soil is improved by removal of soluble salts, thereby helping proper roof development.

(vi) Drainage allows plants to develop better roots which in turn increases the moisture carrying capacity of the soil..

(vii) Drainage due to reason (vi) above increases the available quantity of plant food.

(viii) Deep rooting of plants helps against temporary rough conditions.

(ix) Due to better assertion drainage increase the bacterial activity.

Drainage Methods in the Irrigated Tracts:

It has already been mentioned that drainage methods adopted for humid areas are unfit for those in irrigated areas because in irrigated areas it is the pressure of water down below i.e. high water table which causes water logging. This water has a pressure which tends to bring it upwards and already has a movement which causes it to flow to other areas. The problem therefore is to check.

(a) Lateral movement of water.

(b) Upward movement of water.

(c) If the area is already water logged then the third problem is to remove the excessive salts from the area.

(i) The drain are put not along the direction flow of water as in case of humid areas but across the direction of flow of water so that he water entering the area is trapped by the drains and can no longer flow beyond the drain in appreciable quantities to create menace in the area. There fore as a rule drains in the irrigated section run across the natural slope rather than down the slope. If the drain is made to run the same direction as the natural slope, the water in the drain will run in the same direction or therefore drain will not interrupt any water.

(ii) Since the water is under pressure the drain mentioned in (i) above will only help the area in the close vicinity of the drain and will rise as the distance form the drain increases; therefore it will be necessary to provide parallel drains at reasonable distance determined by actual trials..

(iii) The excessive salts from the land can be removed by flooding and percolating the salts, down. The land has to be leveled before this operation is started. If there are any dunes water will rise in the dunes due to capillary action, leaving deposits of aslats there. The top crust of such tracts is usually made impermeable due to continuous accumulation of water etc. and this has to be ploughed with subsoiler or heavy duty cultivator if proper results are to be obtained.

(iv) The depth of the drains is again governed by the soil conditions, being greater in case of fine grained compact soils that in loose coarse grained soils; since the height to which water rises due to capillary action is greater in the former case than in the latter case. The depth of the drain for proper results should not be less than 6 ft. The drains as a matter of fact should be deep enough to lie in the sand layer below the top clay layer; because it is the sand layer which carries water. The effectiveness of the drain will increase with the depth. Deeper the drain in the sand layer more effective it will be, which is unlike drainage in the humid area. Shallow drains having depth form 2 to 4 ft. as employed in humid regions are useless in case of irrigated tracts. In Imperial valley South California which is irrigated tract, the drains are usually 8 to 10 ft. deep and from 660 to 1320 ft. apart. The distance between the drains is governed by sand strata. If sand strata is not present the spacing may have to be reduced to 440 ft. and if proper sand strata is present the spacing may be as much as half a mile. This is specially true if the sand strata consists of coarse gravel. In Khairpur area for example we have fine sand layers at depth of 8 to 10 ft and therefore spacing of 880 ft. will be most suitable. Average amount of ditch per acre of land therefore will be approximately 75 ft.

Type of Drains:

For irrigated tract there are only two types of drains which will prove satisfactory:-

(1) Open ditch drains.

(2) Tiled drains.

Open ditch drains: - Open ditch occupies considerable space. It is also not safe to irrigate land adjacent to open channel unless there is bund in between. The open ditches require careful maintenance and repairs. They provide harborage for obnoxious weeds. They also require installation of bridges and culverts but their initial cost is very low and they are quite suitable in the new areas where experiments are conducted to find data for proper drainage. They open drains have to be properly designed with side slopes of 1 : 1 in clay, 1 : 2 in loam and 1 : 3 in sand. In Khairpur conditions the slope shall be 1 : 1. the ditches must have proper slopes to carry approximately one cusec of water for every 60 acres o land. A gradient could be taken as 1, 2 or 5 inches for 1000 ft. the slope should be maximum as the natural layout of the land will permit.

Tube wells, open wells, etc. for Drainage:

These seem to be a mis-understanding among the minds of many engineers and agriculturists that a tube well can be used as a measure against water logging. This seems to have been based upon the principle that in new areas wherever pumping has been started water table has gone down. Water logging is caused by water table immediately below the tip clay strata. The water table responsible for water logging is usually between 8 to 50 ft. Down below there is usually an impervious clay layer separating he water bearing strata. In tube wells which are usually between 100 and 250 ft. the water is pumped from the lower stratas leaving the water table un-affected. Thus tube well is not answer to the problems unless the tube well is shallow having total depth up to 50. or maximum will be very small. Even if there is no impervious layer between the various i.e. water bearing stratas are inter connected, the tube well will not help much is reducing the water table because all these water bearing stratas extend to a very great area. To me it appears that water bearing stratus at Khairpur, may be connected with water bearing stratas in area extending up to many miles because apparently there are no hills or other geological formations giving an indication that they will be otherwise. Tube wells will be successful as a measure against water logging only in special conditions like those in San Joaquin Valley, California. Here most of the irrigation is done with the help of tube wells and comparatively less area is irrigated by river water. This valley has rocky formations on East and West slopes and topography is such that ground water forms other areas are not flowing towards this valley. Such conditions fo not exist in the irrigated tracts of West Pakistan. If we assume that 10 to 15% of the total water seeps through the ground to add to the ground water reservoir, it will need a very large number of tube wells to pump out this water.

In San Joquin Valley the ground water is sweet but in our water logged areas ground water is usually brackish specially in case of water logged area of Sukkur Barrage and whole area covered by Ghulam Muhammad Barrage.

In case of tube wells for drainage the vertical movement of the water downwards through the clay layers will be obstructed greatly by these layers, the rate of fall of water table will be comparatively low and water will tend to flow laterally from remote areas directly connected with lower water bearing stratas.

The success of tube wells in San Joquin Valley for purpose of irrigation as well as drainage was mainly due to availability of cheap electric power. In our case we have to resort to diesel engines and even if we use electric motors the power cost will be three to four times that in San Joquin Valley.

Under the circumstances the possibility of using tube wells for drainage may be ruled out. This should however not be mixed with tube well drainage adopted in Punjab where the tube wells are installed near the canal bank to pump water back into the canal.

Open wells are more suitable for this purpose as they are shallow and are located in the water bearing stratas which are again responsible for water logging. Ordinarily discharge of a shallow open well is not more than 1/8 to 1/6 of a cusecs, but it is possible to construct radial wells which will give discharge even upto 2 to 3 cusecs. It may be mentioned here that these wells be very costly as compared to tube wells of same discharge and that is why radial wells are not used for irrigational purpose. The figure attached gives the layout plan of an open well. The cost of building such a well may be about 10,000 rupees.

A well of this type will be constructed in the centre of the area proposed and its suitability as anti-water logging measure will be found out.

Inverted Wells:

Inverted wells have also been used in a lot of areas as a measure against water logging. Drilling upto 170 ft in Khairpur area showed that the water from this depth could rise to 4 ft, below the ground level. The layer at 170 ft. The inverted well therefore will not be a success in that area because for success of inverted well, most essential condition is that sand layed down below should either be dry or only partly filled with water so that it can take water from above.

Proposed Scheme:

It is proposed to take one square mile of mile of water logged area in Khairpur Division or elsewhere with the purpose of reclaiming it of its alkali deposits drainage by leaching of alkali salts. The land shall not be very close to one of the main canal or very far away from it. Representative sample of land will be selected having alkali deposits on the surface but not covered with water at the top. The water so drained will be saturated with slats and will be discharged into the main canal. In all seven open drains each 8 ft. from each other. The ends of these drains will be connected with an 8 ft. deep drain on one side and a 12 ft, drain on the other side. The drains shall have a slope of preferably 7" to 8" inch per 100 ft. if found practical.

Observation wells:

Observation wells consisting of 1 ft. G. I. tubing shall be installed at distance of 110 ft. from each other across the seven drains and at a distance of 1040 ft. along the drains. In order to find out the curve of ground water near the drains additional observation wells shall be installed in the same line across the drains so that they are at a distance of 55 ft. from the drains. The lay out of these is shown in the sketch attached.

Piezometers:

In 36 piezometers consisting of ½" tube shall be installed so as to reach a depth of about 12 ft. One dozen self-indicating piezometers will also be installed, eight of which will be in this area and four in the outside area.

Radial Wells:

One radial well about 20 ft. deep will be installed in the centre of the area for experimental purpose as mentioned above. Some observation wells will be installed in the area outside the experimental area to find out the data about the direction of flow of water, effect of drains on that area etc. The number of piezometers and observation wells in this area will approximately be 36 and 350 respectively, out of which 26 observation wells will be specially to find out effect of radian well on the drainage of the area. The location of these 26 wells outside the area as shown in the map. Eight piezometers will be installed outside the area in addition to the self-indicating piezometers.

THE PURPOSE OF INVESTIGATION IS TO FIND THE FOLLOWING:-

1. Hydrological and Stratigraphic conditions of the area to find out:

(a) *The behaviour of water table.* This will be measured by means of test wells which will consist of observation wells as shown in the sketch attached. The observation wells shall consist of a tube fitted in a well bored by soil auger and with gravel at bottom and sides so that it can show even the water rise due to capillary action the water in this tube well not rise due to pressure as in case of piezometer.

(b) *Change in the quality of ground water* with time due to drainage. Leaching of salts, irrigation and rainfall. The water samples will be tested from time to time to find out carbonates and other soluble salts.

The results will be represented in the following manner:-

April	2.2%	At leaching time.
May	1.0%	Effective removal after leaching.
July	1.2%	Effect of irrigation water containing salts.
October	0.43%	Effect of irrigation water containing salts.

(c) *Direction of underground water:-*
This shall be found out by hydraulic conductivity of stratas of piezometers shall be used (i) Direct indicating type and (ii) tube piezometer consisting of driven tube which will go to a depth of 8 to 15 ft. in water bearing strata and indicate the water pressure. The tube will be driven or fitted in a bored hole and packed with material all around so that it forms a water-right joint with earth round it. By plotting the water table level the direction can be found out.

(d) Seasonal fluctuation of water level which will be measured from the observation wells.

(e) Water Table:- water table at the end of the experiment when conditions have stabilized.

(f) To find out water pressure below at a depth of 20 ft.

(g) To find out suitability of drained water for re-irrigation. In Khairpur area the ground water between 8 and 15 ft. is brackish and un-suitable for irrigational purposes. However further investigation is necessary.

(h) The effect of drainage on the area outside this area, but adjoining the drains. The water, soil sample etc. will be tested and a few observation well also be installed in area surrounding the experimental area.

2. Study of the soil of the area:

(a) To study the composition and movement of alkaline the area before starting the drains and during the experiment. A thorough study will be made to find out the ecect of leaching. For this purpose a doe of about one ft. of water will be given each time. Before giving this application ploughing o land is very necessary. If ploughing is not possible disking and harrowing will be done. Samples shall be taken before next application of water at various depths. The interval between the applications shall be approx 20 days. A large number of samples will be taken at each depth and average salt contents found out and recorded in the following manner:-

Depths in inches	Co_3	Bicarbonates HCO_3	C1	SO_4	Ca	Mg	Na	Boron
0 – 12								
12 – 24								
24 – 36								
36 – 48								

(b) Average chemical composition of water used for leeching and irrigation and its effect on the soil as studied from (a) above.

(c) To find out it there is deficiency of compounds like nitrogenous organic manure, sulphur, calcium and phosphates due to drainage, and if irrigation water has enough of these in gradients to compensate for the losses.

3. To study the size of the drains:

(a) To find out the discharge of water by the drains under stabilized conditions.

(b) To find out the proper depth of drains and how far apart they may be located.

(c) To find out the cost of open drains and cost per acre of land.

(d) To find out how much water is needed to leach saline areas and length of time required to reclaim that.

(e) To find out the lands which were feasible and economical to drain.

4. To find out the crops which could be grown during the time of reclamation:

During the first Kharif Season rice will be grown. During the next year attempts will be made to replace rice by cotton if slats have leeched out, various crops like wheat, barley, linseeds will be tried during the five year period.

The experiment when carried out will give us complete data on reclaiming the land already water logged and the one which may soon get water logged.

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