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USE OF SHALLOW TUBEWELLS FOR SKIMMING AND ANTI WATER LOGGING

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ABSTRACT

The waters in the south western part of the state of Punjab are suitable for irrigation in its upper zone up to about 15 metres and deeper water is saline. To utilise these brackish waters so that ultimately the quality of water in the deeper zone improves, the saline samples can be utilised for irrigation by adequate mixing. The water in the deeper zone where it cannot be applied for irrigation, it may be used for pisciculture through evaporation pits. The salts from these waters may ultimately be collected by evaporation and economically exploited.

INTRODUCTION

After the introduction of irrigation canals, the ground water levels have been progressively rising in certain parts of the country. In the Punjab state also water logging conditions exist its South-Western region irrigated by Rajasthan Canal and Sirhind Feeder. The main factor causing this rise of sub surface water level is seepage from the canals and the effect of infiltration of heavy monsoon to some extent. Recent hydrological surveys have established the progressive rise of water table especially after the introduction of canals in 1959. Actually there is a twin problem of water logging and salinity in the South-Western region. It has been observed that along the vicinity of the major canals and distributaries, the fresh usable water occurs in the upper horizons overlying the saline or very saline ground water belts in the deeper zones.

A hydrogeochemical survey has been conducted by Irrigation & Power Research Institute, Amritsar to ascertain the mineralisation status of the ground water of the region in the vicinity of Rajasthan Canal and Sirhind Feeder from R.D. 87057 to R.D. 102613. The area is bounded by Golewala distributory in the west, Mudki distributory in the East as shown in Figure 1. Soil and sand samples were also collected from 4 number bore holes explored at different sites viz., Rajowala Rest House, Village Pipli, Bhagthala Khurd and Bholuwala situated between Goelwala and Mudki distributaries.

Techniques have been developed to skim off and reclaim the usable canal seepage water without permitting their mixing with the unfit saline water in the deeper zones.Studies have been carried out to develop a bamboo cage coir stainer coupled shallow tubewells system for the reclamation of useable ground water in the upper zones. The deeper saline water layer has

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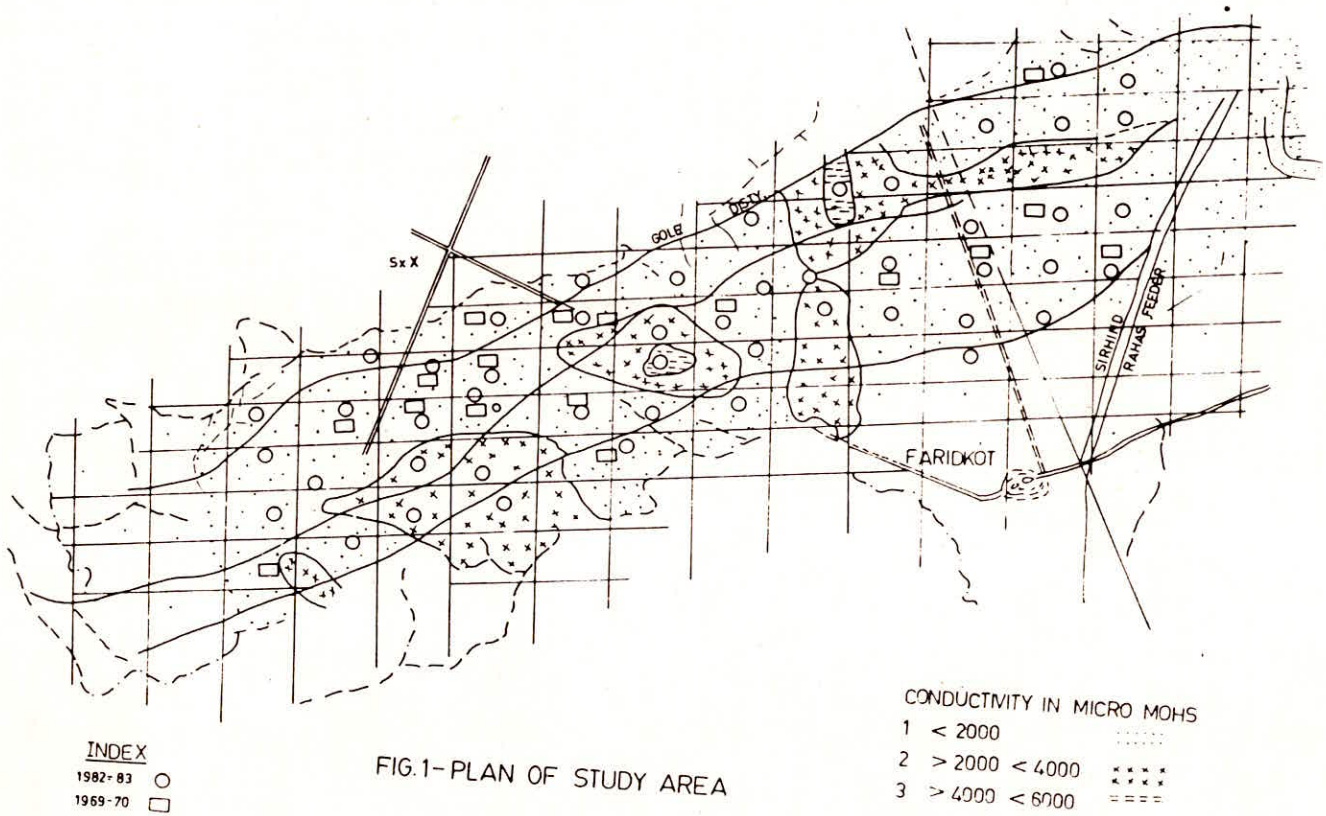

FIG. 1- PLAN OF STUDY AREA

been explored for its utility for pisciculture and the change in quality of water has been the focus of the study. The saline water which finally crosses the limit of tolerance of fish is proposed to be evaporated and the inorganic salts are precipitated. It will benefit firstly in taking out brackish water. In its place, the rain water or good quality canal water will percolate through infiltration which ultimately will improve the quality of ground water of the zone. The application of the saline water will further help in managing the water logged conditions.

OBJECTIVE

The objective of the present study is to locate the good quality water in the saline area particularly in the Faridkot district and to develop the technology for skimming useable canal seepage water in areas where the quality of ground water is unsuitable for irrigation. The deeper water which cannot be utilised for irrigation are proposed to be utilised for pisciculture by raising suitable fish ponds and to revoer salts when concentration of salts increases due to continuous evaporation from water surface of the ponds.

QUALITY OF GROUND WATER

Saline and water logged areas in Faridkot district lies between Golewala and Mudki distributaries towards south-western region on account of seepage from major canals and distributaries. Fresh useable water occurs in the upper zones of very saline ground water belts. In order to observe the sub surface ground water quality, saline area has been demarcated into sixty two number grids. Diesel and electric operated tubewells are present in every grid. From these tubewells sixty two water samples were collected to ascertain their mineralisation status, one water sample was collected from each existing tubewell in the grid. Keeping in view the steady recharging effect due to seepage from Rajasthan and Sirhind Feeders, fifteen more water samples were collected from the the existing tubewells along Rajasthan Feeder for chemical analysis. The other data regarding boring length, diameter, discharge of tubewells and type of engine used for its operation etc. has also been collected. A sample of the data collected is given in Table I,

To ascertain the quality of upper layer ground water in the saline area, water samples collected were analysed for the various characteristics viz., Sodium Absorption Ratio, Salt Index, Conductivity and pH value. The area is highly water logged due to the seepage from the various canals in the vicinity. The problematic areas bounded by Sirhind Feeder, Golewala and Mudki distributaries has been indexed on the basis of conductivity of the water samples tested. It has been found that major portion of the region has water of conductivity ranging between 2000-4000 micromhos/cm. There are small pockets having conductivity between 4000-6000 micromhos/cm. Thus the upper zone water of the region

Table 1 -Quality Ground Water of Samples Collected from Faridkot Area

Sr. No.	Name of Village and location	Boring length	Pipe length in mt.	Dia-meter of pipe	Dia-meter of deli-vry pipe	Water head of tube-wells in mt.	Life of tube-wells in yrs	Dis-charge of tube well in cumecs	Water table in mt.	Type of Engine	SAR Val-ue	Salt In-dex	Con-duc-tivi-ty in micro-mhos/ cm	pH Value
1	Bhagthala Kalan near Mudki drain	12.19 double bore	6.10	3"	3"	1.22	4	0.0113	1.22	D. E. of 5 HP	8.12	+	2250	8.50
2	Pohluwala R/S of Mudki drain	12.19 double bore	6.10	4"	3"	0.97	2	0.0118	1.22	D. E. 8 H.P.	3.40	-	900	8.94
3	Pakhi Kalan L/S one km towards drain	10.67	6.10	4"	3"	0.99	8	0.0102	1.22	D. E. 8 H.P.	4.30	-	1800	8.72
4	Papli Kalan L/S of drain	12.19 double bore	6.10	4"	3"	0.86	12	0.0161	1.52	E.Motor 5 H.P.	9.07	+	3150	8.15
5	Pakhi Kalan near water works	10.36 double bore	4.27	4"	4"	0.60	4"	0.0178	1.52	E.Motor 5 H.P.	5.19	-	1325	8.96
6	Bhaluwala near Bhokwala Bridge	12.19 Triple bore	6.10	5"	5"	0.60	4"	0.0201	1.52	D.E. 8 H.P.	1.62	-	450	8.63
7	Birwala near Birwal bridge	12.19 Triple bore	6.10	5"	5"	0.71	1"	0.0113	1.22	D. E. 5 H.P.	2.94	-	525	8.68
8.	Pipliwala 2km towards Birwala Bridge	12.19 double bore	6.10	4"	3"	0.81	6"	0.0122	1.22	E.M 5 H.P.	3.46	-	675	8.83
9	Pipli towards S.F.side	10.67	7.10	3"	4"	0.95	3"	0.0113	1.22	D.E.8 HP	4.27	-	850	9.18
10	Pipli near Link Road	15.24	6.10	3"	4"	1.15	10"	0.0093	1.22	D.E.8 HP	21.13	+	3750	9.0
11.	Hardialana near Link Road Pakhi to Hardialana	12.19	6.10	3"	4"	1.10	7"	0.0127	0.91	D.E. 8 H.P.	4.88	-	1400	8.85
12	Hardialana near Golewala Disty.	12.08	6.10	3"	4"	0.90	2"	0.0070	0.30	D.E. 8 H.P.	3.65	-	675	9.00
13	Hardialan near Link road Hardialana to Rajowala	13.47	7.32	$2\frac{1}{2}$"	3"	0.95	15"	0.0113	0.60	D.E. 8H.P.	1.73	-	1200	9.20
14	Pipli near drain	10.67+3.05 (cavity)	10.67	4"	3"	1.30	12"	not in working order	1.37	D.E. 8 H.P.	8.63	+	2100	9.30
15	Pipli near Railway line	12.19 (double bore)	6.10	4"	3"	1.13	7"	0.0113	1.52	D.E. 8 H.P.	2.71	-	600	9.15

is mostly suitable for irrigation as it has conductivity less than 2000 micromhos/cm. The test results of the water samples collected are given in Table I. The chemical tests of the water samples have shown that these contain salts of Sodium, Calcium, Potassium and Magnesium, Carbonates, Bicarbonates, chlorides and sulphates. The mineralisation status of the ground water in the saline and water logged area posses corrosion harrds to the conventional M. S. tubewell structure. The two principle effects of the sodium are reduction in the soil permeability and hardening of the soil. Both effects are caused by the replacement of Calcium and Magnesium ions by Sodium ions. The extent of replacement can be estimated by Sodium Absorption Ratio (S.A. R.) which is expressed by the following formula:-

$$SAR = \frac{Na^{+}}{\sqrt{(Ca+Mg)/2}}$$

in which Sodium 'Na), Calcium (Ca), Magnesium (Mg) represent concentration in mili equivalents per litre of the respective ions. The salinity hazards can be estimated by measuring the Electrical Conductivity of the ground water in micro mhos/cm. The various parameters such as S. A. R. values, pH, Salt Index of the water samples collected are also given in Table-I alongwith the conductivity. The proportionate conductivity and pH value of the water samples taken at an interval of 1.5 metres (5 feet) depth are given in Table 2.

SKIMMING TECHNOLOGY

The compound tubewells are generally utilised for pumping out water in saline areas. But due to their very cumbersome design and the requirement of highly skilled and trained expertise for its running and maintenance, the compound tubewells are not recommended for adoptation by agriculture farmers. Experiments were carried out at Irrigation & Power Research Institute, Amritsar to develop coupled tubewells for pumping usable canal seepage water. Four tubewells of 11.5 metres depth and 15.0 cms diameter each having 4.5 metres mild steel blind pipe and 7.0 metres slotted pipe with a double coir stainer, were fabricated. These tubewells were installed at four corners or 4.5 metre square plot. The coupling box was in turn connected to a 15 cms x 15 cms centrifugal pump having 15 B.H.P. electric motor.

To observe the effect of this coupled tubewells on the lowering of water table, piezometric pipes were installed at distances of 1.5m, 4.5m, 12.0m, 27.0m, 57m, 93m, 123m, 138m, 147m, 160m, 162.90m 243.90m and 269.10m respectively. Sluice valves were fixed on all the four tubewells so that these could be run separately as well as collectively. The tubewells were run individually and their discharge was observed at time intervals of 0, 5, 15, 30, 60, 120, 340 and 480 minutes. The tubewells were also run jointly in a simulated fashion i.e. coupled A+B, coupled A+B+C and Coupled A +B+C+D and their discharges were observed at regular intervals.

Table 2 - Proportionate Conductivity of Water Samples

Sample No.	Bore No.	Site Location	Depth of water sample	Actual conductivity in micro-mhos	Proportionate conductivity in micro-mhos	P.H.	SAR value	Salt Index
1/86	I	Rajoowala Rest House	5'-10'	500	500	10.70	1.97	-
2/86			10'-15'	425	350	10.55	3.78	-
3/86			15'-20'	400	350	10.50	3.16	-
4/86			20'-25'	425	500	10.50	2.71	-
5/86			25'-30'	475	675	10.60	3.11	-
6/86			30'-35'	600	625	10.65	2.88	-
7/86			35'-40'	475	325	10.55	1.98	-
8/86			40'-45'	450	275	10.80	2.35	-
9/86			45'-50'	450	450	10.92	2.21	-
10/86			50'-53'	450	450	11.00	2.87	-
11/86	2	Village Pipli near road from Faridkot to firo2 pus about 1 km from Mudki drain	5'-10'	900	900	11.10	5.06	-
12/86			10'-15'	1100	1300	10.75	10.99	-
13/86			15'-20'	875	425	10.65	6.67	-
14/86			20'-25'	775	475	10.90	8.00	-
15/86			25'-30'	900	1400	10.95	8.19	-
16/86			30'-35'	825	450	11.15	10.34	-
17/86			35'-40'	750	300	11.25	4.11	-
18/86			40'-45'	800	1150	11.05	4.61	-
19/86			45'-50'	750	350	11.10	5.33	-
20/86			50'-55'	700	250	10.95	5.91	-
21/86			55'-60'	1000	4000	11.20	6.91	-
22/86			60'-65'	1100	2200	11.30	10.92	-
23/86			65'-70'	1300	3700	11.35	15.42	-
24/86	3	Bhagtthala Khurd 1 1/2 K.M.from Sirhind feeder to Golawala Disty.	5'-10'	1900	1900	10.55	7.96	+
25/86			10'-15'	1800	1700	10.75	7.58	-
26/86			15'-20'	1350	450	11.05	7.50	-
27/86			20'-25'	1200	750	10.80	9.70	-
28/86			25'-30'	1300	1700	10.55	9.19	-
29/86			30'-35'	1250	1000	11.00	6.21	-
30/86			35'-40'	1100	200	11.00	5.04	-
31/86			40'-45'	1200	1900	11.10	5.97	-
32/86			45'-50'	1100	300	10.65	4.31	-
33/86			50'-55'	3500	conductivity too high	11.00	25.89	+
34/86			55'-60'	7000		11.1	58.21	+
35/86			60'-65'	7500	-do-	11.20	55.57	+
36/86			65'-70'	7500	-do-	11.40	52.84	+
38/86	4	Near Primary School Bholu Wala	10'-15'	1500	1500	11.30	11.00	-
39/86			15'-20'	1200	900	11.40	23.12	-
40/86			20'-25'	900	300	10.50	4.64	-
41/86			25'-30'	900	900	10.60	3.63	-
42/86			30'-35'	825	525	10.95	4.59	-
43/86			35'-40'	850	975	11.00	4.41	-
44/86			40'-45'	800	500	11.10	4.09	-
45/86			45'-50'	750	400	10.80	Sample	-
46/86			Sample discharged.					

To study the effect of pumping of coupled tubewells on the lowering of water table in the vicinity of experimental tubewells, water table observations were made through the set of piezometres installed for the purpose. These observations were made at regular intervals of 5,30,60,120, 240 and 480 minutes respectively which are given in Table 3.

EFFICIENCY

The coupled tubewell developed has been found quite efficient and economical to cope with the situations as prevalent in problematic sline areas. A perusal of the results of experiments (Table 4) reveals that whereas with 2 tubewells coupling 55% to 60% discharge and 28% to 33%, saving in electric consumption was achieved, the 3-Tubewells coupling,resulted in 110% to 125% additional discharge and 40% to 45% saving in energy consumption per 0.0283 cumecs (One cusec) discharge of water. With four tubewell coupling there was an additional discharge of 160% to 175% and a saving of 45% to 50% energy for 0.0283 cumecs (one cusec) of water pumped out.

A perusal of the results (Table 4) indicates that with 2-coupled tubewell operating at a discharge of 0.018 cumecs the lowering of water table was of the order of 0.34 metre at a distance of 27 mts. from the tubewells after a time period of 8 hrs. since the start of pumping thereby registering a gain of 20% to 25% additional discharge over single tubewell, but with 3-tubewell coupling (discharge 0.025 cumec) the lowering was of the order of 0.60 metre under similar condition of distance and duration of pumping. Hence it can be safely inferred from the foregoing discussions on experimental results that working of 4-coupled tubewells on the same pumping set (7.5 H.P. motor and 15 cms x 15 cms centrifugal pump) is very simple, efficient and economical.

PISCICULTURE

The disposal of brackish water from the deeper depths needs attention. The water firstly can be utilised in conjunction with good quality water in the upper zone of about 12 months. The water also becomes suitable for irrigation by direct mixing before irrigation or by intermittent irrigation with good quality waters so that the soils do not deteriorate. In case the waters cannot be utilised for irrigation in any way either due to its too much brackish quality or due to the water logging conditions available in that area. The soils of the area might have already turned into saline or alkaline conditions. Even the industrial plants may not function with this water due to the highly saline water available there. The main salts in these waters include Sodium, Calcium, Magnesium, Potassium, Chloride, Sulphate and Bicarbonate. The water containing these ions in excessive limits becomes heavier due to the inorganic salts and denser than the fresh water. The two liquids tend to remain separate. In the absence of turbulence, they become separate with fresh water lying at the surface of the salts waters. These waters are mainly due to the seepage from the canals and from the percolation of irrigation in the sub surface. The survey of

Table 3 - Statement showing the performance of coupled Tubewells

Time	Tubewell Design Specifications, Discharges, Distances of Piezometer and water table depth in metres											
	Coupling A+C Discharge=0.018 cumecs				Coupling A + B + C Discharge=0.025 cumecs				Coupling A+B+C+D Discharge=0.031 cumecs			
	1.5 m	4.5m	12.0m	27.0m	1.5 m	4.5m	12.0m	27.0m	1.5m	4.5m	12.0m	27.0m
5 min.	0.78	0.43	0.20	0.09	1.07	0.65	0.35	0.13	1.62	1.13	0.51	0.23
30 min.	1.18	0.86	0.43	0.19	1.19	0.94	0.53	0.25	1.99	1.52	0.70	0.30
1 hour	1.26	0.96	0.50	0.21	1.19	0.97	0.60	0.34	2.12	1.67	0.82	0.36
2 hour	1.33	1.03	0.56	0.28	1.27	1.04	0.62	0.35	2.23	1.78	0.94	0.45
4 hour	1.36	1.06	0.62	0.30	1.34	1.08	0.65	0.38	2.57	1.88	1.03	0.52
8 hour	1.41	1.14	0.65	0.34	1.44	1.16	0.72	0.42	2.46	1.96	1.15	0.60

Table 4 - Statement showing increase in discharge and electric consumption per unit discharge

S. No.	Tubewell Coupling	Average steady discharge cumecs	Increase in dish. % over single T/well	Electric consumption per unit dish.	Net lowering at 27 mt after 8 hours	Net saving in lect. connt. % age
1	A	0.0114	-	10.88	0.27	-
2	A+C	0.0178	56.20	7.15	0.34	33.50
3	A+B+C	0.0255	55.10	6.12	0.42	43.76
4	A+B+C+D	0.0311	175.00	5.86	0.60	47.10

the quality of water in the south west part of Punjab matches very well with the surveys conducted by Geological Survey Department in United States. The European investigators too observed the sub surface waters in the same fashion with fresh water in the upper zone, supplemented by brackish water in the deeper zone. They reported the zone of diffusion between frest and salts water in both these areas about 20 metres thick which is the prevailing condition in the brackish water zone of Punjab. To manage this problem, despressions in the area may be utilised for preparation of evaporation pits. Often too many pits are required. When due to evaporation, the water of pits crosses the tolerance limits of fish, the same can be transferred to the other pit and allowed to develop there. The water in the pit is allowed to further evaporate so that salts could be collected. The pits may be only earthen with polyethylene film at the bed and sides to avoid the seepage of the water. The salts can be used as such for washing or other industrial purposes. Even the individual salts can be separated by simple techniques so that their commercial utility increases. The maximum temeperature during the summer months of May to September is above 40° C and the minimum is more than 20°C. In the remaining months of the year, the temperature is favourable as the humidity is usually low. Both the factors are favourable to a high rate of evaporation. Seepage, however, from these pits needs to be controlled by the use of polythene film at the bed and sides of the earthen pits.

UPCONING

While skimming it is essential to see that the underground saline water could not get mixed with the upper zone sweet water due to upconing. In fact there exists an optimum well penetration into the fresh water layer which permits maximum discharge without salt water entrainment. The optimum penetration increases as the vertical permeability increases relative to the horizontal permeability. Extensive pumping of water from ground water resources in certain areas of Salinity Control and Reclamation Projects (SCARP) has resulted in upconing of saline water. As a result of which many public tubewells were closed on farmer's request on account of discharging brackish water unfit for irrigation.

Izharul-Haq and Javed have reported that"the fraction of the water pumped out of the well which comes from the saline water displacing fresh water can be estimated from the volume of the cone times the pore space of the aquifer divided by the amount of water pumped. The continued pumping results in a larger and larger fraction of the pumped water coming from the displacement of fresh water by saline water. This is due to the interface coming closer to the well.

CONCLUSION

The waters in the South western part of the state of Punjab are suitable for irrigation in its upper zone up to about 15 metres and deeper water in saline. To utilise these brackish waters so that ultimately the quality of water in the deeper zone

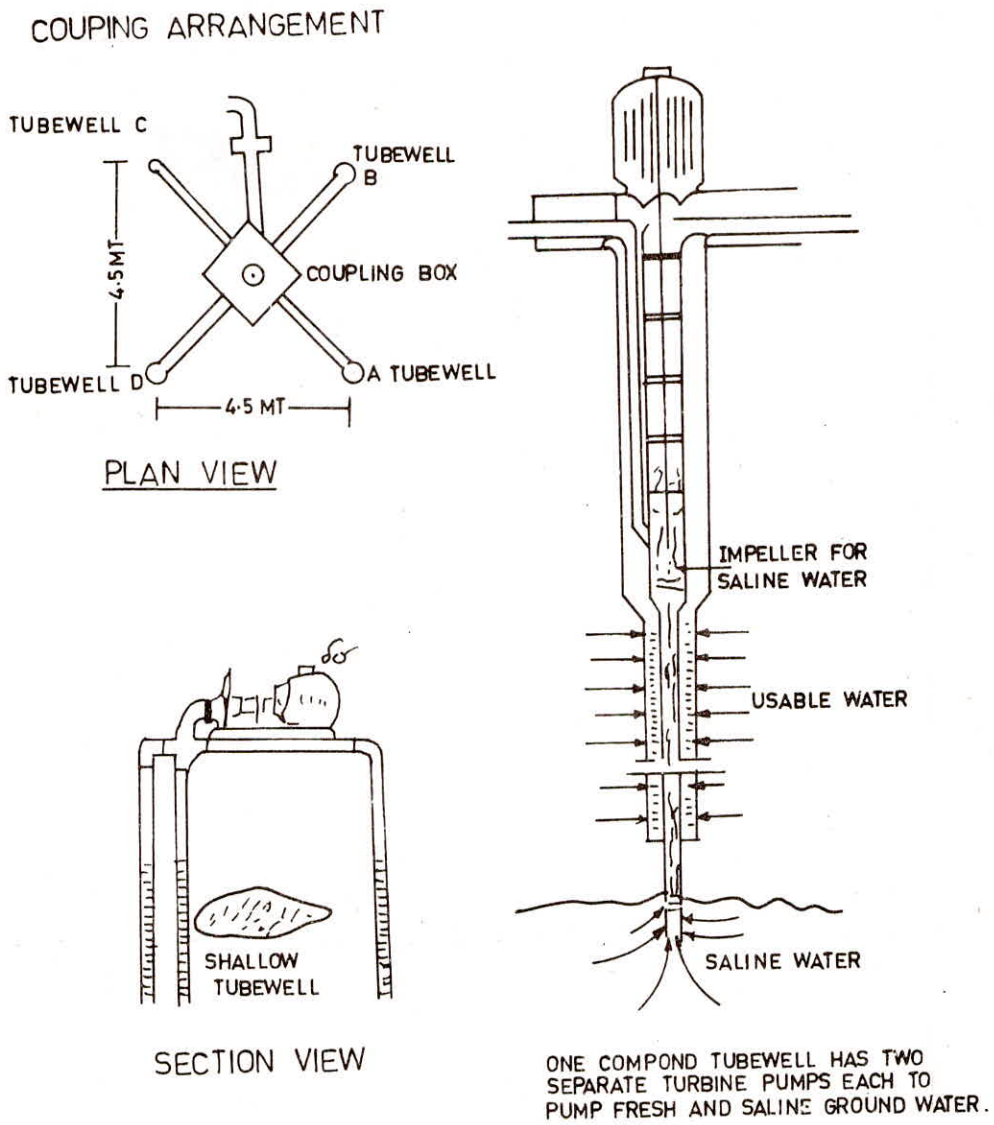

FIG. 2 - COUPLED TUBEWELL DEVELOPED FOR

improves, the saline samples can be utilised for irrigation by adequate mixing. The water in the deeper zone where it cannot be applied for irrigation, it may be used for pisciculture through evaporation pits. The salts from these waters may ultimately be collected by evaporation and economically exploited.

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