

Research Report No. 70  
Statistical Series on Private  
Tubewell Development in West Pakistan  
PURCHASE OF WATER FROM PRIVATE TUBEWELLS  
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## P r e f a c e

Since 1964 the Agricultural Section of the Pakistan Institute of Development Economics, under the leadership of the late Mr. Ghulam Mohammad, has been conducting extensive investigations into the growth of private tubewells in West Pakistan. As part of this programme we have conducted several field surveys on various aspects of the development - probably the best known being the Annual Surveys of Private Tubewells, the fifth of which will be conducted this year. Most of these surveys have been carried out in conjunction with the West Pakistan Department of Agriculture.<sup>1/</sup>

Partial results of these surveys have appeared in several articles written by Mr. Ghulam Mohammad<sup>2/</sup>, but much of the data had not been fully processed and detailed results had not been published. Since West Pakistan's private tubewell development is of such general interest, both to the planners concerned with irrigation development in West Pakistan and, more widely, to many economists concerned with the problems of agricultural development, we have decided to reprocess all of the more important surveys and publish the results in a series of PIDE Research Reports entitled "Statistical Series on Private Tubewell Development in West Pakistan". The data published in this series along with the results of our other research on this subject are being further analysed and will be published in a PIDE Monograph which should appear in the Fall or Winter of 1968.

E.H.C.

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<sup>1/</sup> We must express our deep appreciation to the West Pakistan Department of Agriculture, especially the Lahore Region and its Director, Mr. Shafi Gill, for their generous cooperation in this work, without which most of it could not have been carried out.

<sup>2/</sup> Particularly, "Private Tubewell Development and Cropping Patterns in West Pakistan", Pakistan Development Review, v.V, n.1, Spring 1965, pp 1-53; "Development of Irrigated Agriculture in East Pakistan: Some Basic Considerations", PDR, v.VI, n.3, Autumn 1966, pp.315-375; "Programme for the Development of Irrigation and Agriculture in West Pakistan: An analysis of the Public and Private Groundwater Development Programme and the IBRD Draft Report", PIDE Research Report No. 59, July 1967. This last publication to be superseded by a forthcoming article in the PDR by Ghulam Mohammad and Edwin H. Clark, "Groundwater Development in West Pakistan: An Analysis of the IBRD's Recommendations".

## I n t r o d u c t i o n

In the Fall of 1965 and again in the Summer of 1966, the Agricultural Section of the Pakistan Institute of Development Economics under the direction of the late Mr. Ghulam Mohammad, conducted a survey on the use of private tubewell water by non-owners as well as tubewell owners. Mr. Ghaffar did the field work, surveying nineteen villages located in four districts. A list of the villages is given in Table I.

The survey was conducted by interviewing all of the available farmers in the village to determine their use of tubewell water and other inputs. This was found to be much more accurate than only surveying the tubewell owner. Each village (excepting those in Sialkot) was surveyed twice - once in the Fall of 1965 to obtain data regarding the 1964/65 Rabi season and the 1965 Kharif season, and again in the summer of 1966 to obtain data on the 1965/66 Rabi season.

The attached tables present village summaries of the purchase and use of private tubewell water for each of the three cropping seasons. Quantities of irrigation water used are measured in acre irrigations. (One irrigation applied to five acres gives five acre irrigations.) This is a relative rather than absolute measure of quantity since the depth of water applied per irrigation is not known. This may differ from crop to crop and from locality to locality. It is presumed, however, that one tubewell irrigation is equivalent to one canal irrigation applied to the same crop.<sup>1/</sup>

Often the tubewell water and canal water were mixed together in irrigating the field. In such cases the surveyor divided the total number of acre irrigations equally between the two sources. Since the tubewells generally supplied slightly more water than the canal, this would also tend

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<sup>1/</sup> This may not be true if the rate of flow of water from one source is significantly different from the rate of flow from the other source. The farmer's target is to flood the field to a certain depth. If the tubewell provides a higher rate of flow than the canal, the tubewell irrigation may supply a smaller total amount of water since more seepage will occur during the longer time required by the slower source to flood the field to the desired depth. The farmers generally estimated that the tubewell would, in fact, irrigate a field in about 10% less time than the canal. No attempt was made to adjust the figures to take account of this possible bias.

to bias the results. Again, no correction was made.

For perennial crops such as sugar cane, all the irrigations were included in the Kharif figures even though some of the water would have been applied during the Rabi season.

The attached tables show the total number of interviews conducted in the village and the amount of land farmed by the farmers interviewed. If several farmers were farming their land jointly, they would be covered by one interview, so the number of interviews is not necessarily equal to the number of farmers covered by the survey. Nevertheless, it is clear that the surveys did not include every farmer in the village although it does appear as if they covered almost all of the village area. We can conclude that it was mostly the smaller farmers who were not included. This means that the results probably accurately represent the impact of tubewell water on total production though it is still not clear how this impact is distributed among farmers owning different amounts of land.

The figures showing cropped acreage are for the farmer's (either owner or purchaser) total cropped acreage, not for the cropped acreage to which tubewell water was actually applied. There was usually only a small difference between these two measures - most farmers applying both tubewell water and canal water to the same land. Where there is a difference, we believe that the figures presented are more meaningful than the figures on the amount of land actually receiving tubewell water. The important question is the total amount of water available to the farmer, not how he allocates water from various sources to different crops. It should make no difference to total crop production whether a farmer spreads tubewell water over all his land or concentrates it on a small part of the land, freeing canal water for use on the other land.<sup>2/</sup>

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<sup>2/</sup> Nor does it matter (unless the groundwater is saline) if the farmer's land is fragmented and the tubewell water is not available to all of the fragments, except in the unusual situation where the fragments are served by different water courses. The farmer can allocate his supplies of canal water among his fragments as he wishes.

One unexpected, but quite important finding came out of this survey. This was the fact that tubewell owners (and perhaps occasionally purchasers) will sell their rights to canal water as well as their tubewell water. The canal water is mostly sold to farmers who want to purchase additional water but cannot be supplied from a tubewell (either because their land is situated at a higher elevation than the tubewell or because there are physical obstructions). Since canal water is considered superior to tubewell water the selling price of canal water is reportedly higher. This explains why in some villages the tubewell owners reported using no canal water on their land although it was used by everyone else in the village.

This practice is apparently more common in the Gujranwala-Sialkot area, where the groundwater is quite fresh, than in the Lower Bari Doab where there are potential salinity problems. Subsequent investigations have indicated that it has been practiced in both locations, although we have not had the opportunity to collect any quantitative data regarding the amount of water transferred through such sales. Nevertheless, it is clear that because the tubewells supply enough water to permit such transfers, they have an even wider impact than is indicated by the data showing the amount of tubewell water purchased.

When the tubewell water was sold for cash, the rate was generally between two and three rupees an hour, but sometimes going as high as four rupees an hour. Different rates would be found in the same village. Unfortunately, there was no way to determine whether the rate is a fraction of the size of the well or of some other factors.

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TABLL - I

List of Villages

	<u>District</u>	<u>Tehsil</u>	<u>Sub-Tehsil</u>	<u>Village</u>	<u>Area (in acres)</u>	<u>Population</u>
A	Sialkot	Daska	-	Nanoke	685	483
B				Bhattewad	584	579
C				Burj Araian	(556) <sup>a/</sup>	<u>a/</u>
D	Gujranwala	Gujranwala	-	Kotmetla	206	309
E				Ratoke	288	156
F				Q. Balwant Singh	436	436
G				Jogi Wala	875	573
H				Tung Khurd	608	247
I				Kule Wal	857	195
J	Sahiwal	Sahiwal	Chichawatni	105/12-L	1,557	1,005
K				103/12-L	1,341	1,119
L				27/11-L	1,015	573
M				23/11-L	1,623	634
N				32/12-L	1,570	1,854
O	Multan	Vehari	Burewala	447/E-B	741	818
P				443/E-B	436	626
Q				449/E-B	652	310
R				469/E-B	843	637
S				503/E-B	952	789

Sources:- Areas are taken from Village Statistics of West Pakistan, W.P. Bureau of Statistics, 1960, and 1961 Census figures (Village lists). Population taken From 1961 Census Figures (Village lists).

Notes:- a/ Burj Araian could not be located in the Village lists having apparently changed its name since 1960. The area shown is that reported by the village headman at the time of the service.

Table II

DISTRICT SUMMARIES

	<u>3 Villages Sialkot ( Daska )</u>	<u>6 Villages Gujranwala (Gujranwala)</u>	<u>5 Villages Sahiwal ( Sahiwal)</u>	<u>5 Villages Multan ( Vehari)</u>
Rabi 1964-65				
Number of Interviews	68	116	217	148
Number of Tubewells	15	10	22	11
Number of Tubewell Owners	13	8	55	19
Number of Purchasers Tubewell Water	3	12	113	90
Percent Cropped Land Supplied with Tubewell Water	41%	41%	85%	77%
Percent Irrigations Supplied by Tubewells				
Owners	98%	58%	53%	72%
Purchasers	25%	34%	22%	21%
All Interviews	59%	37%	32%	29%
Kharif 1965				
Number of Interviews	68	116	217	148
Number of Tubewells	19	15	23	11
Number of Tubewell Owners	17	13	56	19
Number of Purchasers Tubewell Water	20	26	116	119
Percent Cropped Land Supplied with Tubewells Water	78%	77%	90%	97%
Percent Irrigation Supplied by Tubewell				
Owners	99%	53%	56%	73%
Purchasers	90%	51%	31%	40%
All Interviews	87%	41%	39%	47%
Rabi 1965-66				
Number of Interviews	-	100	212	156
Number of Tubewells	-	13	26	15
Number of Tubewell Owners	-	13	58	14
Number of Purchasers Tubewell Water	-	32	123	135
Percent Cropped Land Supplied with Tubewell Water	-	62%	93%	97%
Percent Irrigations Supplied by Tubewell:				
Owners	-	77%	65%	59%
Purchasers	-	77%	42%	30%
All Interviews	-	46%	50%	39%



Table III

## Purchase of Water from Private Tubewells - Rabi 1964/65

Village	<u>District Sialkot</u>			<u>District Gujranwala</u>					
	A	B	C	D	E	F	G	H	I
Number of Tubewells	3	6	4	1	1	3	3	0	0
Number of Interviews	25	23	20	13	15	29	10	31	18
Total Area Owned	637	521	401	180	277	449	883	458	478
Total Cropped Acreage	452	271	229	96	205	291	387	242	85
Total Acre Irrigations from Canal	1030	480	598	292	158	650	2816	795	770
Owners-Number of Interviews	3	6	4	1	1	3	3	0	0
Area Owned	143	267	180	19	40	225	577	0	0
Cropped Acreage	148	111	95	5	23	145	210	0	0
Acre Irrigations from Canal	0	0	0	0	0	0	1765	0	0
Acre Irrigations from Tubewell	1035	1054	703	32	80	2001	520	0	0
Purchasers-Number of Interviews	0	3	0	2	7	1	2	0	0
Area Owned	0	76	0	26	132	32	50	0	0
Cropped Acreage	0	43	0	10	71	25	25	0	0
Acre Irrigations from Canal	0	12	0	22	12	0	102	0	0
Acre Irrigations from Tubewell	0	213	0	36	257	215	116	0	0

Table III (Contd.)

## Purchase of Water from Private Tubewells - Rabi 1965/66

Village	<u>District Sahiwal</u>					<u>District Multan</u>				
	J	K	L	M	N	O	P	Q	R	S
Number of Tubewells	5	4	3	4	7	2	1	2	4	2
Number of Interviews	20	35	26	41	95	25	34	28	24	37
Total Area Owned	1115	1213	724	1357	1614	622	287	631	791*	803
Total Cropped Acreage	592	698	367	720	843	350	224	328	530	444
Total Acre Irrigation from Canal	2528	3545	1970	2772	3711	1497	884	1204	1876	3151
Owner-Number of Interviews	5	4	3	4	39	2	1	10	4	2
Area Owned	520	151	165	332	754	114	12	227	159	65
Cropped Acreage	301	99	79	178	436	57	7	116	95	47
Acre Irrigation from Canal	1061	376	195	484	1748	150	22	0	306	156
Acre Irrigation from Tubewell	1132	370	437	684	1896	214	36	734	358	284
Purchasers-Number of Interviews	14	28	17	17	37	23	33	14	20	0
Area Owned	566	955	510	547	650	508	356	328	632*	0
Cropped Acreage	281	552	239	293	286	293	217	172	435	0
Acre Irrigation from Canal	1415	2887	1478	1097	1355	1347	862	937	1570	0
Acre Irrigation from Tubewell	269	776	226	631	555	499	586	179	668	0

Table IV

## Purchase of Water from Private Tubewells - Kharif 1965

Village	<u>District Sialkot</u>			<u>District Gujranwala</u>					
	A	B	C	D	E	F	G	H	I
Number of Tubewells	5	6	8	2	3	3	3	1	3
Number of Interviews	25	23	20	13	15	29	10	31	18
Total Area Owned	637	521	401	180	277	449	883	458	478
Total Cropped Acreage	321	345	313						
Total Acre Irrigation from Canal	878	182	668	352	227	1527	5783	3639	4525
Owners-Number of Interviews	5	6	6	1	2	3	3	1	3
Area Owned	208	257	213	19	50	225	577	40	270
Cropped Acreage	169	213	217	13	27	205			
Acre Irrigation from Canal	0	0	30	0	3	704	3388	398	2836
Acre Irrigation from Tubewell	1615	3488	3795	157	461	2492	3828	398	1100
Purchasers-Number of Interviews	5	12	3	7	10	3	6	0	0
Area Owned	80	210	48	115	188	47	295	0	0
Cropped Acreage	31	113	29	72	107	40	259	0	0
Acre Irrigation from Canal	97	92	66	276	86	136	2290	0	0
Acre Irrigation from Tubewell	165	1709	440	417	1224	391	818	0	0

Table IV (Contd.)

## Purchase of Water from Private Tubewells - Kharif 1965

Village	<u>District Sahiwal</u>					<u>District Multan</u>				
	J	K	L	M	N	O	P	Q	R	S
Number of Tubewells	5	4	3	4	7	2	1	2	4	2
Number of Interviews	20	35	26	41	95	25	34	28	24	37
Total Area Owned	1115	1213	724	1357	1614*	622	287	631	791*	803
Total Cropped Acreage										
Total Acre Irrigation from Canal										
Owners-Number of Interviews	5	5	3	4	39	2	1	10	4	2
Area Owned	520	231	165	332	754	114	12	227	159	65
Cropped Acreage	289	174	73	180	520	71	10	110	111	33
Acre Irrigations from Canal	976	534	105	703	2087	201	36	0	387	120
Acre Irrigations from Tubewell	1398	634	448	1047	2080	405	57	748	483	262
Purchasers-Number of Interviews	14	30	18	23	31	23	33	17	20	26
Area Owned	566	981	509	696	584*	508	356	391	632*	597
Cropped Acreage	264	625	305	317	245	283	242	234	356	284
Acre Irrigations from Canal	1426	2375	2377	1260	1143	1151	1044	639	985	1221
Acre Irrigations from Tubewell	402	1475	379	1037	701	806	953	369	985	480

Table V

Purchase of Water from Private Tubewells - Rabi 1965/66

Village	<u>District Sialkot</u>			<u>District Gujranwala</u>					
	A	B	C	D	E	F	G	H	I
Number of Tubewells	-	-	-	1	3	3	3	1	2
Number of Interviews	-	-	-	11	16	21	14	18	20
Total Area Owned	-	-	-	186	245	424	763	500	860
Total Cropped Acreage	-	-	-	90	160	196	362	258	126
Total Acre Irrigation from Canal	-	-	-	175	0	284	1024	1079	922
Owners-Number of Interviews	-	-	-	1	2	3	3	2	2
Area Owned	-	-	-	19	63	200	549	166	185
Cropped Acreage	-	-	-	10	47	90	264	85	20
Acre Irrigations from Canal	-	-	-	0	0	30	484	140	0
Acre Irrigations from Tubewell	-	-	-	56	151	725	858	185	162
Purchasers-Number of Interviews	-	-	-	4	14	13	0	0	1
Area Owned	-	-	-	67	182	141	0	0	16
Cropped Acreage	-	-	-	32	113	74	0	0	7
Acre Irrigations from Canal	-	-	-	32	0	202	0	0	16
Acre Irrigations from Tubewell	-	-	-	101	331	371	0	0	22

Table V (Contd.)

Purchase of Water from Private Tubewells - Rabi 1965/66

Village	<u>District Sahiwal</u>					<u>District Multan</u>				
	J	K	L	M	N	O	P	Q	R	S
Number of Tubewells	5	4	4	4	9	2	3	2	6	3
Number of Interviews	30	34	19	40	89	32	34	31	31	28
Total Area Owned	1312	1195	623	1351	2202	637	356	623	756	805
Total Cropped Acreage	686	631	339	695	848	328	205	341	438	367
Total Acre Irrigations from Canal	2100	1980	1033	1938	1869	1536	890	1280	1660	2132
Owners-Number of Interviews	5	5	5	4	39	2	3	0	6	3
Area Owned	406	200	254	300	431	88	44	0	227	110
Cropped Acreage	227	130	141	166	436	52	28	0	146	61
Acre Irrigations from Canal	852	368	250	392	859	204	127	0	426	296
Acre Irrigations from Tubewell	988	644	546	882	1975	284	141	0	610	470
Purchasers-Number of Interviews	24	29	5	34	31	28	29	31	25	22
Area Owned	881	995	220	1008	1218	506	308	623	529	590
Cropped Acreage	451	501	111	507	293	257	175	341	292	279
Acre Irrigations from Canal	1224	1612	429	1471	628	1221	755	1280	1234	1635
Acre Irrigations from Tubewell	823	1315	248	735	779	350	313	755	378	892

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