

Private Tubewell Numbers in Pakistan: A Synthesis

by

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One of the foremost examples of development through private entrepreneurship is the case of farmer investment in tubewells in Pakistan and the supply industries which have arisen to provide tubewell components and installations. The phenomenon has been frequently studied, in some cases before regular statistical series of tubewell numbers emerged. As a result several independent estimates are available, largely derived from surveys, which are not wholly consistent with each other. Some series include only private tubewells, some combine private and government tubewells into one inseparable figure while others do not specify. Some data reflect a December thirty-first situation while others represent June thirtieth. Varying survey techniques have been used. Quantitative analysis of this facet of Pakistan's development is impeded by these problems. This note seeks a synthesis; to provide an internally consistent time series which is at once as reliable and as long as possible.

THE SOURCES

The estimates given by the most important sources are summarized tabularly in Appendices I and III and presented graphically in Appendices II and IV. This section elaborates the methodology behind each set of estimates in order to identify their distinctive characteristics. Most figures are expressed as of the end of the crop year. Where rapid growth is occurring, one must be careful to recognize that a single figure can represent only a point in time. Hence, for instance, the 1969/70 figure for most series is an estimate for June 30, 1970. One source discussed below presents estimates as of December 31st, the close of the calendar year. Adjustments are made accordingly in the analysis. Also, each series is reported on a net basis—i.e., only functioning tubewells are counted. Thus, annual increases correspond to net additions to the stock of tubewells.

No estimates of gross tubewell construction—i.e., net additions plus replacements—are available but the annual level of replacements could be derived by employing Afzal's tubewell life estimates [10].

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The distinction between government and private tubewells is blurred in several series. The distinction can conceivably be made in terms of the installing agency or the operating agency. Survey techniques which inquire about the year of installation of existing wells probably cannot satisfactorily separate the installing agencies *ex post* where the wells are privately operated at the time of the survey. Hence the government vs. private distinction is used in this paper to refer to the agency of operation. Private tubewells are those operated by farmers, or possibly cooperatives of farmers.

Pakistan Institute of Development Economics

Among the first analysts to examine tubewell development was the late Ghulam Mohammad, Senior Research Economist at PIDE. Under his leadership a series of surveys was begun in 1964 and conducted annually through 1966-67 enumerating tubewells and their characteristics.

In the first year of this survey, sampled farmers were asked to identify the year of installation of tubewells then in existence and their responses were used to construct a series for earlier years. Since the survey sought data as of the close of the particular crop year, June thirtieth, it may be assumed that data derived for earlier years represent the same time point.

Ghulam Mohammad published a report in which his survey data for installations between 1955-56 and 1964-65 form the base for projecting installations through 1985 [3, p. 42]. This paper was one of the first to clearly point out the developmental potentials of tubewells in Pakistan.

After Ghulam Mohammad's death in 1967 these data, including the previously unpublished figures for 1965-66 and 1966-67, were further analyzed by Edwin H. Clark and Mohammad Ghaffar and published in a three part "Statistical Series on Private Tubewell Development in West Pakistan". One of the three [1] dealt explicitly with tubewell installation rates.

In their discussion Clark and Ghaffar point out certain under-enumeration problems resulting from sampling procedure and mission returns. Questionnaires were completed by Field Assistants of the Agricultural Extension Service; personnel who had a great many other duties, limited mobility and too large an area to serve. Results of the final survey for 1966-67 were inconsistent with official figures published by the Government of West Pakistan for the entire province. Accordingly, Clark and Ghaffar revised upwards the last three years of Ghulam Mohammad's data in order to tie into the official statistics. Their final 53,000 is a rounded version of the government's 52,872.

Board of Economic Inquiry, Punjab

Another early source is a report published in 1965 by M. Ghulam Yasin of the Punjab Board of Economic Inquiry reporting data from his 1963-64 survey [4]. Field work lasted a full year in Multan and Sahiwal District with intensive measurements being taken on a sample of 100 tubewells in 24 villages. Unfortunately no details are given as to the source or methodology behind Appendix I which lists tubewell numbers working and out of order for 1954-55 through 1962-63. Data are contained for 16 districts of Punjab and for Bahawalpur State and N.W.F.P. Present Punjab can be approximated by

summing the 16 districts plus Bahawalpur State. Government of Punjab statistics show only 84 tubewells in Jhelum, Rawalpindi and Campbellpur Districts in 1963-64, so the exclusion of these three districts in this earlier study is inconsequential. Another unknown is the extent to which these figures include government as well as privately installed tubewells. One can assume that government tubewells constituted less than ten percent of total since only 1389 government wells were present in Punjab in 1963-64, one year after Yasin's figures showed a total of 12,248. I have assumed these data reflect the June 30 situation because of the way they are labeled.

Government of Punjab

Official statistics are available from the office of the Deputy Secretary (Statistics), Agriculture Department, Government of Punjab, Lahore. Separate series are maintained for government and private tubewells, further disaggregated by power source and location. These data also reflect the situation at the end of the crop year.

Until mid-1970 this office had responsibility for West Pakistan. A tubewell series was begun for West Pakistan in 1966-67. However, due to shifting responsibilities resulting from the division of West Pakistan into four separate provinces and an inadequate publication budget since that time, only two years of official estimates were made by this office for what is now Pakistan[8].

Official data are available, however, for Punjab from the Deputy Secretary (Statistics) covering the period from 1967-68 to date [7]. In fact these are the only Punjab figures available for the years since 1969-70. These data are collected by a cadre of statistical officers and enumerators scattered throughout Punjab. Personnel in the program now have several years of experience and training, statistics are their sole responsibility and verification checks are part of the process. Hence these official data may be considered relatively reliable estimates for the June 30th point in time.

The Farm Mechanization Committee

In 1968 a specially constituted Farm Mechanization Committee conducted an extensive survey of the use of mechanical equipment particularly tractors in Pakistan. This study was completed over an extended period of time and is the most complete study of farm mechanization ever undertaken in Pakistan. The committee's emphasis was tractors and associated equipment, however, and their report [2] contains only brief mention of the historical development of tubewells. Figures are included for 1954-55, 1959-60 and 1968-69.

West Pakistan University of Engineering and Technology

In 1969-70 the West Pakistan University of Engineering and Technology conducted an extensive survey of the role of tubewells in the water development of Pakistan [9]. Data for estimating tubewell installation rates were drawn largely from mail questionnaires. Of the three groups from whom responses were solicited, returns of 60, 50 and 30 percent were obtained. No effort to interview non-respondents is indicated in the text, hence non-response bias cannot be ruled out.

Figures on the yearly installations of private tubewells are given. Field work began in the Fall of 1969 and ended in February of 1970 with mail questionnaires being received throughout that period. Hence these data probably approximate the situation as of December 31, 1969. In this respect they are six months out of phase with other estimates. Where tubewell numbers are growing at 10-12,000 per year, the figures from this study might differ from other series for the same year by 5-6,000. Annual installation figures are used to build an estimate of total installations by accepting the Farm Mechanization Committee's figure of 1780 existing tubewells in 1954.

DISCUSSION

An interesting point becomes apparent when looking at the charts in Appendices II and IV. In each case where a retrospective time series was constructed from a single survey, the data reported for the year of the survey deviate below the trend. Ghulam Mohammad's data for 1964-65, Yasin's data for 1962-63 and the Engineering University's data for the end of 1969 all are below what would have been predicted based on their respective estimates for earlier years.

Three explanations are possible. First, the technique of asking the installation year of existing tubewells may overestimate their numbers. This seems unlikely since, if anything, some wells could have gone out of production and been forgotten thus giving lower estimates for earlier years.

Second, the final figure could be under-reported because farmers attempt to downplay their recent prosperity. This motivation has been often hypothesized in the Sub-continent but never proved. However, it seems more logical that if such motives exist they would result in a uniform depression of several recent years rather than only the last one.

Finally, enumerators could be underestimating numbers in the year of study because their respondents were not fully aware of all of the most recent installations. This would result in the single year aberration which seems to characterize such studies.

Tubewells in Pakistan

The series of figures for the early years given by Ghulam Mohammad correspond closely to other estimates. His figures are only 480 and 580 below those of the Farm Mechanization Committee for 1954-55 and 1959-60 respectively. Except for 1964-65 his estimates follow the same trends as those of the Engineering University but 1000-1500 units lower. Since upward bias is suspected in the latter estimates, one can accept Ghulam Mohammad's figures as the most accurate annual series for the period 1954-55 through 1963-64.

The Clark and Ghaffar revisions of Ghulam Mohammad's data for the years 1964-65 through 1966-67 provide a continuation of the series which links directly with the official estimate in the latter year. Accepting these two sets of data together gives a growth pattern estimated from a single data base for the 13 years from 1954-55 through 1966-67. In our final sequence we have used the official figure of 52,872 for 1966-67 rather than the rounded 53,000 since the former was based on a more complete enumeration process.

Official figures are available for 1966-67, 1967-68, 1969-60 and 1970-71 which are consistent with the trend evident in the data discussed above. Since the two were linked by the Clark and Ghaffar revision, it is appropriate to accept these government figures as a continuation of the same series.

1968-69 is missing from this series due to reporting problems associated with the repatriation to their own provinces of government statisticians when West Pakistan became four provinces. The Farm Mechanization Survey, however, estimates 75,720 private tubewells for this year, a figure which coincides almost exactly with the trend line. It also falls exactly on the trend shown by the Engineering University but this would not have occurred had their final year not dropped below what their previous year's data would have suggested. In the absence of an official estimate, the Farm Mechanization Survey's estimate is the best for 1968-69 and is incorporated in the final series.

Tubewells in Punjab

The earliest figures dealing separately with Punjab are those of Mr. Yasin of the Punjab Board of Economic Inquiry. His figures, except for the year of his survey show the same relationship to the Engineering University data as did Ghulam Mohammad's data in the case of the Pakistan estimate. There is no apparent reason not to accept Yasin's estimates for 1954-55 through 1961-62 even though little is known about them.

For 1962-63, Yasin's data show the end-of series downward bias already mentioned. Clark and Ghaffar offer an estimate which is consistent as if Yasin's data had continued along a trend parallel to that of the Engineering University study. No revision was made by Clark and Ghaffar for 1962-63 or 1963-64. These two years were accepted for inclusion in the Pakistan series and warrant inclusion in the Punjab series as well.

The Punjab government figures provide a series of acceptable reliability that connect with the unrevised Clark and Ghaffar estimates in 1963-64. In the case of the Pakistan series we have accepted the Clark and Ghaffar revised estimates for 1964-65 and 1965-66 since they provide the best linkage between Ghulam Mohammad's data and the official statistics beginning in 1966-67. For Punjab, Clark and Ghaffar's revised estimates lie well above what appears to be the actual developmental path for this period. This is probably the result of their sample being concentrated in Punjab and thereby possibly overstating the Punjab proportion of total tubewells. If that were the case, an upward revision that equated estimates for all Pakistan would leave the revised estimates for Punjab laying above official figures.

One anomaly is worth mentioning from the official statistics. As mentioned above, the personnel relocations associated with the disaggregation of West Pakistan resulted in a serious disruption in the statistical report services. As a result the all Pakistan figure for 1968-69 is not available. A further result of these events was a considerable delay in receiving tubewell counts from areas of Punjab. While these were all eventually tabulated, late reporting caused some of the figures, which should have been reported in 1968-69, to be included in the 1969-70 estimates. As a result the government figures contain a downward deviation in the trend followed by an upward deviation from trend established in previous years. In order to adjust for this problem we have taken the

growth between 1967-68 and 1970-71 and distributed it evenly over the three intervening years. In this manner the number of private tubewells is estimated to have been 63,891 and 72,852 in 1968-69 and 1969-70 respectively.

CONCLUSION

Using the logic elaborated above, the series of figures below are derived for private tubewell numbers in both Punjab and all Pakistan for the years 1954-55 to the present.

<i>Year</i>	<i>Punjab</i>	<i>Source</i>	<i>Pakistan</i>	<i>Source</i>
1954-55	1,216	4	1,300	3
1955-56	1,495	4	1,600	3
1956-57	1,893	4	1,900	3
1957-58	2,108	4	2,200	3
1958-59	3,184	4	3,300	3
1959-60	4,084	4	4,60	3
1960-61	6,767	4	8,000	3
1961-62	9,619	4	13,000	3
1962-63	15,258	1	18,400	1,3
1963-64	21,776	7	25,000	1,3
1964-65	28,746	7	34,400	1
1965-66	36,217	7	43,500	1
1966-67	44,888	7	52,872	8 (Vol. II)
1967-68	54,930	7	65,336	8 (Vol. III)
1968-69	63,891	7*	75,720	2
1969-70	72,852	7*	85,729	5
1970-71	81,814	7	94,638	5
1971-72	90,456	7		
1972-73	99,025**			

*Adjusted

**Preliminary

Comparing the two series, one discovers an irregular pattern to the difference between them in the early years. In particular, the number of tubewells in Pakistan excluding Punjab drops from 105 in 1955-56 to merely 7 the following year. Again in 1962-63 the number of wells in the rest of Pakistan declined by 239 from the year before, recovering only two years later.

In part, this difficulty arises from the fact that Ghulam Mohammad's data for these earlier years are available only in thousands, rounded to the nearest decimal point. An examination of the two series, however, shows that Ghulam

Mohammad's series for Pakistan grows at a much steadier rate than does that of Yasin for Punjab. The latter contains a sequence of annual installations of 398, 215 and 1076 for the years 1955-56 through 1958-59, an erratic pattern for an industry that contained enough firms to be fairly competitive.

Since no information is available on either the source of Yasin's estimates or the actual unrounded figures of Ghulam Mohammad, there is no basis to adjust either series. One is left with the situation that either series may be used by itself but that they may only be used together if one is prepared to ignore minor inconsistencies in the early years.

Compound growth rates evident from these series are as follows for selected periods:

<i>Period</i>	<i>Punjab</i> (%)	<i>Pakistan</i> (%)
1954-55—1964-65	37.2	38.8
1965-66—end of series	16.1	16.8
1954-55—1959-60 (First Plan)	27.4	28.8
1959-60—1964-65 (Second Plan)	33.5	33.9
1964-65—1969-70 (Third Plan)	20.4	20.0
1969-70—to date (Fourth Plan)	12.2	—

Assuming that the spread of high yielding varieties enhanced the demand for supplemental water, then the period from the beginning of the Third Five Year Plan is most meaningful in terms of defining the tubewell industry today. Because of the ever growing base, percentage growth rates have declined. For those years in which our series is complete, the industry has averaged 10,228 tubewells annually over and above replacements in Pakistan as a whole. Excluding the most recent figure, which is still preliminary, an average of 9040 additional wells were installed annually in Punjab alone.

The quantity of tubewells is obviously only one factor in measuring the importance of tubewell water to total water availability. Both the tubewell capacity and the overall rate of utilization must be known before the total contribution of tubewell water can be assessed. Unfortunately, data on both capacity and capacity utilization are not available. Nevertheless, the consistent time series for tubewells presented in this paper should improve the analysis of the role of tubewells in the development of Pakistan's agricultural sector.

SOURCES

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