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Tubewells | farmer participation

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TECHNICAL APPRAISAL OF FARMERS TUBEWELL SCREENS IN PAKISTAN

BY

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SYNOPSIS

Pakistan has a total gross area of 90 million hectares of which nearly ¼ i.e. 25 million hectares is under cultivation; and another 11 million classified as culturable waste. On more than 15.76 million hectaters irrigated Agriculture is practiced. A significent feature of Pakistan's Irrigated Agriculture is its Indus Irrigation System which is the biggest single gravity flow irrigation net work on the surface of globe (with more than 40,000 miles of irrigation channels capable of handling more than 100 million acre feet of water) However, surface supplies are short of the water requirements of crops, so to meet the growing demand ground water is being utilized through more than 300 thousand public and private tubewells installed mainly in the Province of Punjab. Various types of screens such as coir string, nylon string, cement, P.V.C.,mild steel, brass and fibre glass have been used.

As large number of farmer's tubewells (though of small capacity) performed well towards supplemental water supply through efficient exploitation of sweet ground water, besides meeting drainage requirement in those areas, government is now implementing a transition programme to close down its deep large capacity tubewells by encourging the farmers to install their own shallow tubewells. Since technical and economic appraisal of different screens was done during the last 22 years, under different research projects on tubewells, in the Irrigation Research Institute, Lahore, in this paper, an effort has been made to elucidate the salient aspects of tubewells screens of farmers tubewell such as behaviour of different screens under different water quality and soil strata, etc. Also important conclusions and recommendations are being made on the basis of research and investigations. It is hoped that these will prove highly beneficial not only for Pakistan but also for other countries of South East Asia.

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INTRODUCTION

Despite its declining relative importance, agriculture continues to be the mainstay of Pakistan economy. It contributes about 30% of its G.D.P., Provides about $\frac{2}{3}$ of its total exports and employs approx: 55% of country's labour force. It has close linkages with other sectors of economy so that it deserves greatest attention. However, with less than 150 mm of average annual rain fall the Indus Basin, where agricultural lands are mostly located lies in arid and sami arid zone. Thus artificial irrigation is must for sustained agriculture. In the past to meet the irrigation requirements the country was almost entirely dependent on its canals where the largest/contigous gravity flow net work in the world was built. However, as there was scarcity of surface water as compared to need of its cultivable area, despite construction of two big Dams to store surplus flood waters, it became essential to supplement the surface water supplies to meet increasing strain on land due to food and fibre requirements of growing population. Thus the tubewells in recent years have gained equal importance. It may be stated that in Punjab alone against a total estimated diverted discharge of 54.50 MAF (6.72 Million Hectare Meters) through canals the tubewells are pumping about 39.85 MAF(4.92 MHM) supply at present. It cannot be, however, over looked that availability and quality of subsoil water in Indus vally alluvium is wholly dependent on fresh surface water recharge by seepage from canals, rain water and rivers etc.

HISTORY OF TUBEWELL INSTALLATION

Since surface supplies have been short and less as compared to consumptive use of crops, progressive farmers started installing their own tubewells to augment the canal supplies or to raise their crops in barani areas. Thus by 1940 there were 439 such tubewells installed in Punjab alone (Agricultural Census, 1960).

Government on the other hand also, from 1945 onwards installed a large number of tubewells under Grow More Food Schemes and later as anti water logging measures (through Rasul Tubewells Project and Salinity Control and Reclamation Projects- (SCARPS). Thus in 'Punjab' about ten thousand tubewells have been installed in public sector. Most of these tubewells are deep and have electric driven, high capacity turbine pumps (2-5 cusecs) or 0.0566-0.142 Cumex).

During early sixtees Government started encouraging farmers to install their own tubewells by granting concessions, loans, subsidies etc. Thus the number of small capacity private tubewells increased to 21,776 by June, 1964 and to 2,71,719 by June, 1991. The year wise and cumulative number is shown in diagram I. The capacity of these tubewells was however, small and the cost of irrigation by tubewell remained much higher than canal water charges levied by the government.

The farmers have installed their tubewells mostly in good quality ground waters areas. However, in brakish ground water area also as generally shallow water quality (due to seepage from canal etc) is good, the farmers have installed tubewells in depths varing from 80 feet to 120 ft (24-36 meters)where depth of strainers range from 60 to 100 ft. The Capacity of these tubewells varies from 0.5 cusecs to 1.25 cusecs(0.0142-0.0425 Cumex) and installed Horse Power from 10-15 H.P. for electric tubewells and 15-20 H.P. for diesel engine operated units.

Although there are many advantages for the farmers in the installation of their own tubewells but in the private sector growth of shallow tubewells is mainly due to their low initial cost using indigenous techniques and equipment; and complete control on operation of the tubewell to arrange needed irrigation water on"ON DEMAND BASIS".

OTHER BENEFITS OF FARMER'S TUBEWELLS

Besides adequate and timely supply of water through out the year, Tubewells have enabled their owners to bring their culturable waste land under plough and the intensities of cultivation have also increased.

Another beneficial effect of practising tubewell irrigation has been the lowering of water table. Large tracts of lands affected by this menace have been reclaimed by tubewells and are yielding good harvests.

As regards the social benefits, the owners of tubewells command great respect among their fellow farmers and are economically better. Fueds over the distribution and turns of canal waters have declined in such areas. The local Industry and technical know-how is increasing in the country, which is a good sign for a developing nation. As the farmers are becoming more and more conscious of their investments they are putting their idle period of motive power to other uses, such as saw mills, grinding mills, etc.

SALE OF TUBEWELL WATER BY FARMER

Many tubewell owners who have surplus water than for their own use sell water to their fellow cultivators. The cost of tubewell water is generally negotiated. If paid in cash it ranges between Rs.25/- to 50/- per hour for electric and diesel tubewells. In the shape of crop produced, the farmers are generally found to sell water at higher rates as compared to cash payment. In any case as it is higher than cost of production this business has been profitable for many of them and thus has affected their socio-economic aand even political structure.

Quite a few farmers have installed tubewells on cooperative basis, but the experience is not as good as in other countries, where water users associations are handling water supply problems for irrigated agriculture.

PRESENT PRECTICES AND
WELL SCREENS INSTALLED

Shallow tubewells facilities are basically designed to be operated using locally manufactured equipments and more so centrifugal pumps. As location of pumps within the suction depth of water level is critical, even in areas where pump cannot be located at land surface a sump (typically brick lined) is constructed near to the water table at the well site where centrifugal pump, delivering through a discharge pipe to a brick built surge tank is placed. The wells are completed at 6 inches diameters with well screens chosen either from their own past experience or on advice by local artisans.

It is to be observed, however, that screen is the most important component of a tubewell because although the economics of pumped water would depend on many factors but useable life of a strainer is one of the major item. Its function is to hold back the formation and allow sand free water to flow into it. For water to flow freely with least obstruction or resistance, a strainer should have proper type of slits or holes. The area and size of these slits should correspond to the characteristics of the formation and type selected should also suit water quality.

WELL SCREEN USED IN PAKISTAN

i) Coir string wound on M.S. cage.
ii) Nylon string wound on M.S.cage.
iii) Brass slit type.
iv) P.V.C. slit type.
v) Cement slit type.
vi) Mild steel slit type.
vii) Fibre glass slit type.

i) Coir String Strainers.

Mild steel casing with screen of coir rope or string wrapped on mild steel cage has been the earliest and most commonly type used. A coir strainer consists of iron bar on M.S. round cage of 5 to 8 inches diameter, generally with single twisted string wound on it. Very few had a punched iron sheet around the strainer as protection for the coir. Generally length of strainer is 40 - 120 ft (25-35 meters). Water flows through the pores of coirs of fibre; and mainly from the interstices between two strings.

Laboratory studies have shown that with an open area of about 12%, this continuous type screen provides greatest open area for slot opening. Also permeability of single wound coir string is 2.52×10^{-2} cm/sec while that of medium sand formation is 4.284×10^{-2} cm/sec.

A coir strainer's life varies from area to area depending on water quality and soil strata. However , in Punjab Province such tubewell components have been found to have a life of more than 7 years in fresh ground water conditions.

ii) Nylon Strainers.

Nylon string is wound on M.S. cage in the same way as coir strainer. However, the diameter of Nylon-6(commercial name), generally used, is 1.7 mm and is formed by winding 210 number yarn x 15 ply x 3 final studs (i.e. 45 yarns in the string). The specific gravity of the thread (which would dissolve in concentrated Hydrochloric Acid) is 1.14 . It has a breaking load of approximately 143 lbs,which is sufficient to bear strains of suction,lateral earth pressure, hammering effects etc.

Preliminary studies have shown that under suction it elongates 38% in dry condition and the elastic recovery of the string is 98-100%.Wet and dry strength ratio is 0.87.

Although the open area of Nylon String wound strainer is less than coir string but as during suction elongation occurs in-flow into the strainer increases . In some installed tubewells, the upper one-third portion of strainer is of nylon string while the lower portion is of coir string. However, in case of increased draw-down as the order of surges at the start and at the close of the pump are very high,so the upper portion is also wound by nylon string.Presently,therefore, full length of nylon wound screens are being used in some areas.

iii) Brass Strainers.

Brass strainers have generally slot sizes of 12/1000 x 2½ inches giving an open area of 4 to 5 per cent. Some of these have been shrouded by gravel of the size of 1/16 to 3/16 inches. The studied tubewells which had yallow brass strainer (composed of 65% copper & 30% Zinc) were found to have installed before 1970; proving that this type of strainer has longer life as none of the brass strainer tubewells has been re-bored to date. However,because of its high price, it is not being used by the farmers.

iv) P.V.C. Strainers.

Poly-Vinyle-Chloride (P.V.C.) slotted screen is a relatively recent innovation. The slit sizes very from 12/1000 to 14/1000 inches and the open area from 4 to 6 %. This screen is being used by farmers with high hopes because the P.V.C. material is inert to many chemicals and it does not corrode and is less liable to incrustation. It is of light weight and is much less costlier than brass and fiber glass.

The average length of surveyed P.V.C.strainers was 80 ft. The areas in which clay lenses damage coir screens, the farmers prefer P.V.C.screens.

v) Cement Strainers

The cement pipe is made locally by spinning method or by hand-moulding. Stretched galvanized iron wire is used as the re-inforcement. Before curing, in the green condition, "10/1000 to 14/1000 x 2" to 3" size slots are made. The strength of the pipe depends upon the sand cement ratio and curing methods etc. During slit making an extra-ordinary care and craftsmanship is needed. The uniform width of a slit is rarely seen. Out of the surveyed tubewells, only one tubewell was shrouded, and it was visually observed that all the other unshrouded tubewells were yielding a little sand. The open area of slots is about $1\frac{1}{2}$ to 2%. The length of cement filter installed generally varies from 80 to 120 ft. (25 - 35 meters) IRI surveys and experience during implementation of Scarp Transition Pilot Project revealed that cement screens are becoming popular, being the cheapest one.

Many cement screen manufacturing concerns were visited and many defects were noted in their manufacture; such as material was not of standard quality, mix-ratio of mortar was lean and re-inforcement material was also of low quality. So research is needed to develop standards for more durable and better cement strainers.

vi) Mild Steel Strainers

These are scarcely used in the private sector, but were used extensively in public sector SCARPS tubewells. The mild steel screens used are 8" or 10" diameter and the slot sizes are 2,5/8" x 1/16". The open area is 30 sq. inches per ft. length of the strainer.

Even during early operation, it was noticed that serious deterioration had set in and the yield of wells started to fall quickly. So the sponsors were faced with serious problems because whereas the useful life of a tubewell was assumed to be about 40 years, a sharp fall in the yield after a short period (due to corrosion and incrustation) was a matter of concern to authorities. In the specific type of Indus Valley formation, mild steel screens were generally found to be unfit and as such they have been discarded for future installation in public and private sector.

vii) Fibre Glass Strainers

It is an epoxy bonded fibre glass material. The argument put forth for the use of costly strainer in the public sector was that it is non-corrosive and resistant to incrustation. However, it is not strong enough to be pulled out and recovered.

These strainers were used in SCARP-II & III areas of Punjab where dia of strainer varied between 10 inches to 8 inches and the slot size was "3/32" x $1\frac{3}{4}$ " and 1/16" x $1\frac{1}{4}$" for respective diameter strainers. There are no tubewells having this type screen in the private sector.

According to Planning & Development Survey through the University of Engineering and Technology, Lahore in 1969, 93% of tubewells were having coir string strainers. IRI survey in 1972 revealed that the coir string screens was used in above 70% cases where as about 20% tubewells were installed with cement screen. Experience during implementation of Scarp Transition Pilot Project (1987-90) and present survey during 1991-92 shows, that in reborings and new installations the farmers are preferring cement strainers over coir strainers etc. as these are very cheap, available every where and can be easily installed by village mechanics. However, in farmer managed Irrigation Systems, tubewells are installed by them without any expert advice, just according to their own experience or counsel by local artisans, only on economic/cost considerations and as per available technology with them.

DETERIORATION OF FARMER TUBEWELL SCREENS

Though the farmers generally install tubewells in shallow good quality water ,yet corrosion and incrustation problems are encountered, as discussed below:-

CORROSION, INCRUSTATION AND
RENOVATION OF TUBEWELLS SCREENS.

It is found that most commonly used coir string deteriorates in areas having clay lenses. Moreover if water is corrosive, it corrodes iron cage and the rust also damages the coir string wound on it. Thus it is recommended to use cages of either inert material like P.V.C. or use anticorrosive paints on M.S. cages. Cement strainers produced locally by a number of manufactures have different lives ,due to quality of cement used, curing methods and time allowed ; and size of slits, etc. So there is a lot of scope for improvement in these screens. In areas of low water quality farmers prefer to use P.V.C. slit type screens, as these are non corrosive. Mostly farmers do not use shrounding around their tubewells screens, though it is highly desireable especially around slotted screens.

The commonly used renovating acids were tried to judge their real effectiveness in renovation of choked screens. It has been observed that renovating acids are very harmful to coir strainers and cement strainers. So these should not be used in any concentration for the said strainers.

In the absence of efficient and econmical renovation methods particularly coir strainers and cement strainers , farmers are obliged to arrange a new bore and installs a new strainer as soon as the running of a choked tubewell becomes uneconomical.

The research is therefore to be continued to develope some suitable technique to renovate choked wells efficiently and economically. The IRI is presently engaged on development of an ionic bombardment technique, based upon electrolysis of common salt (i.e.Nacl) for the renovation of choked metalic tubewell screens.

CAVITY WELLS (WITHOUT SCREENS)

Cavity wells are now being recommended to be installed specially in abandoned Riverian areas of flood plains, in the Indus Plain. Where alluvial deposition occurs , and with the geological process of centuries, clay lenses are compacted with fresh deposits of the bed load of flowing rivers.
A cavity well is not very deep and just requires sufficiently hard clay strata to form a strong and dependable roof above the cavity. Quite contrary to screens, which are incrustated with passage of time when their discharage is reduced. In case of cavity wells, with the passage of time, the discharge increases as the dia of cavity increases. Cavity well has longer life than conventional tubewells, provided discharge is optimum and water pumpage is controlled. So it is suggested that not more than 0.5 cusecs water should be pumped from a cavity well.

SALE OF TUBEWELL WATER BY FARMER

Many tubewell owners who have surplus water than for their own use sell water to their fellow cultivators. The cost of tubewell water is generally negotiated. If paid in cash, at ranges between Rs.25/- to 50/- per hour for electric and diesel tubewells. In the shape of crop produce , the farmers are generally found to sell water at higher rates as compared to cash payment. In any case as it is higher than cost of production this business has been profitable for many of them and thus has affected their socio-economic and even political structure.

Quite a few farmers have installed tubewells on cooperative basis , but the experience is not as good as in other countries, where water users association are handling water supply problems for irrigated agriculture.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of various research studies on farmers tubewells screens, the following main conclusions and recommendations are made:-

CONCLUSIONS.

i) Out of 3,00,000 tubewells in Pakistan there are 2,72,324 farmer tubewells in Punjab, 70,758 are electric driven and 2,01,566 are diesel operated.

ii) The well screens, most commonly used by the farmers are coir-string screens, cement screens and P.V.C. screens.

iii) Farmers use locally made Centrifugal pumping units and all screens are country made in the private sector.

iv) According to the latest surveys, coir string screens and cement sloted screens are very popular in the farming community of Pakistan.

v) Farmer's tubewells are yielding one cubic ft. of water per second on the average and their working hours are 25% of the available hours.

vi) Farmers install tubewells in shallow good quality waters, so corrosion and incrustation problems of screens are generally not very serious.

vii) As there are no efficient and economical methods for renovation of chocked wells, so farmers install cheap strainer, locally made, and when discharge of a tubewell reduces more than 50%, they usually install a new screen.

viii) The farmers, with their long experiences on behaviour of different types of screens, try to select such screens as may suit their water quality and soil strata.

ix) Some farmers install tubewells on cooperative basis and some other farmers sell their water to their neighbouring farmers.

x) As farmers are managing groundwater fairly efficiently, so the Government has made a 'Transition Programme' under which deep tubewells installed under Salinty Control and Reclamation Projects (SCARPS), particularly in sweet water zones, are being closed and farmers in these areas are encouraged to install shallow tube wells with cheap, locally made screens.

RECOMMENDATIONS

i) Farmers tubewells should be encouraged by the Government and maximum facilities in supply of electricity and granting loans to the farmers should be given . A farmer realises full cost of his tubewell within a few years.

ii) In string wound screens, atleast 30 ft length of blind pipe must be used just beneath the reflux valve. If the suction is within a string wound screen region, the string may break easily because of negative pressure created within casing/screen, causing failure of the tubewell.

iii) In areas where there is sweet water overlying saline water and water table is not deep, the use of multiple strainers run by a single centrifugal pump may be tried by the farmers for skimming sweet water.

iv) Wherever sloted screen made of brass, cement, P.V.C. Fiber glass are used, shrounding with well graded material should be used . Proper shrouding wrap with due consideration to the grade of sand of the formation will improve the inflow velocity, thereby increasing the useful life and yield of a tubewell.

v) Manufacturing of screens must be standardised and advice through extension services should be given to farmers and manufacturers.

vi) Renovation method should be developed to clean screens in situ to enhance the life of a tubewell. Acids are very harmful to coir strainers and cement strainers so these should not be tried for their renovation.

vii) Areas should be surveyed and demarcated for cavity wells (without screen tubewells) as these are more economical and cheaper than screen wells.

viii) Equilibrium between sweet and saline water zone and intrusion of saline water into sweet water should be studied and measures should be taken to avoid deterioration of groundwater, as deteriorated water affects not only crop production but also the useable life of a strainer.

ix) The possibility of use of telescopic screens in the private Sector should be studied in detail.

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TYPE OF STRAINEES USED BY FARMERS IN SCARP TRANSITION PILOT PROJECT.

SCARP TUBEWELL NO.	NO. OF PVT T/W INSTALLED IN PLACE OF SCARP TUBE WELL.	TYPE OF STRAINER			DEPTH OF BORE	LENGTH OF STRAINER
		COIR STRING ON IRON CAGE.	CEMENT.	PVC		
216	6	2	-	4	100 - 110	70- 80 ft.
218	18	7	1	10	100 - 110	70- 80 ft.
196	6	2	-	4	110 - 130	70- 80 ft.
198	9	2	-	7	100- 120	65- 85 ft.
199	15	2	-	13	100 - 120	70 - 80 ft
201	21	6	-	15	100 - 150	70 - 80 ft.
202	14	12	-	2	150 - 180	120 - 150 ft.
205	10	5	-	5	100 - 115	70 - 80 ft.
206	8	4	-	4	100 - 115	70 - 80 ft.
210 / 211	13	3	9	1	100 - 120	75 - 80 ft.
174	5	4	-	1	115- 180	80 - 150 ft.
200	6	5	-	1	130 - 180	100 - 150 ft.
203/ 204	14	3	3	8	100 - 115	70 - 80 ft.
172	5	5	-	-	150- 210	120 - 180 ft.
178	8	4	2	2	100 180	70 - 150 ft
164	7	7	-	-	150 - 210	120 - 180 ft.
170	8	7	-	1	110 - 180	80 - 150
171	9	9	-	-	150 - 220	120 - 200
173	5	4	-	1	120 - 150	70 - 120
177	3	3	-	-	120 - 150	90 - 120
183	18	10	-	-	90 - 150	90 - 120
171	1	1	-	-	150	120

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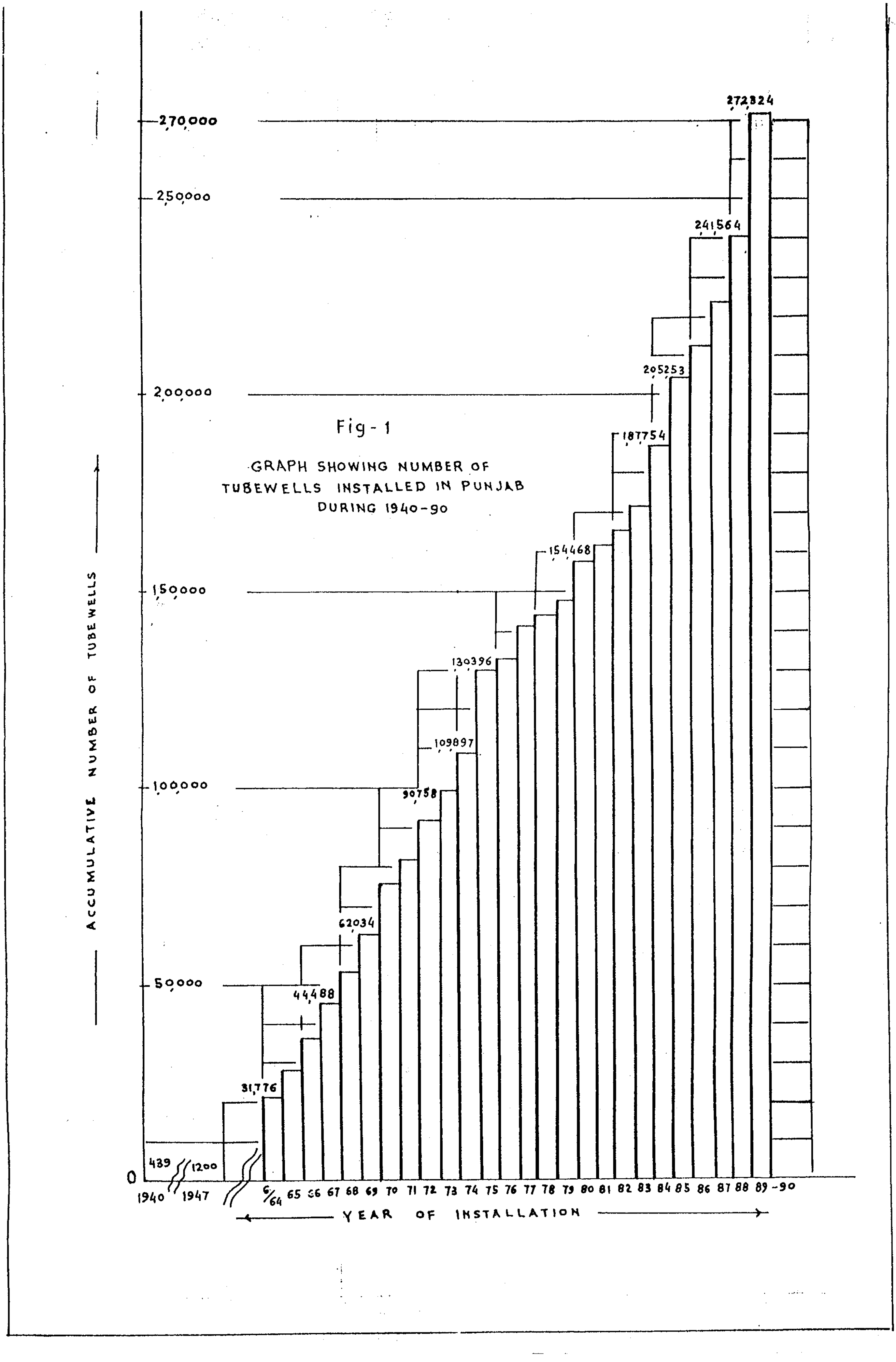

Fig - 1

GRAPH SHOWING NUMBER OF TUBEWELLS INSTALLED IN PUNJAB DURING 1940-90