

Paper No. 175

# OPERATION AND MAINTENANCE OF COMPLETED SCARPS

Hamid Ullah Khan,

*Director, Salinity Monitoring*

Syed Rehmat Ali,

*Director (M&E), Fourth Drainage Project*

Muqarrab Khan,

*Senior Engineer*

## OPERATION AND MAINTENANCE OF COMPLETED SCARPS

By

\*HAMID ULLAH KHAN

\*\*SYED REHMAT ALI

\*\*\*MUQARRAB KHAN

### SUMMARY

Although detailed information could not be gathered from the respective Irrigation Departments regarding the pertinent data on the Operation and Maintenance of completed SCARPS due to shortage of time, yet an attempt has been made to highlight the performance of some of the completed SCARPS (I to IV in Punjab, Peshawar in NWFP and Khairpur and North Rohri in Sind) in respect of depth to water table, soil salinity, water quality, cropping intensity, yield, etc. and the factors responsible for the dwindling achievements of the SCARPS have been investigated.

The basic objectives of the SCARPS are (i) to eradicate waterlogging and salinity (ii) to bring the areas thus rescued under crop through supplemental irrigation supplies (iii) to improve the agricultural productivity through better farm management, increased inputs thereby raising the intensity of agriculture and yields. The performance of the tubewells is adjudged by the pumping capacity and capability of the tubewell in delivering the designed discharge and the utilization factor. The general causes responsible for reduction in the specific capacity are corrosion and incrustation of well screens and choking of gravel pack. It has been observed that the pumpage was maximum in the early years of commissioning and thereafter it dropped in almost all the SCARPS mainly from the deterioration of the tubewells and low utilization. The observations on depth to water table have revealed that the area underlain by 0-150 cms depth was considerably reduced in the earlier stages but rise in water table was generally observed at later periods in almost all the SCARPS because of less pumpage and comparatively more canal supplies in some of SCARPS.

Similarly a lot of improvement was observed in the surface as well as profile salinity with the SCARPS in the early stages. However a reduction in salt free area has been observed in some SCARPS mainly due to gradual rise in water table, decreased

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- \* *Director, Salinity Monitoring*
  - \*\* *Director (M&E), Fourth Drainage Project*
  - \*\*\* *Senior Engineer*

pumpage and use of brackish water without proper mixing. A deterioration in water quality from 3 to 10 percent was observed in SCARPS-I to IV in the Punjab, Khairpur and North Rohri in Sind. No significant change was noticed in Peshawar SCARP. The crop acreage and cropping intensity increased rapidly at the outset but became slower subsequently due to deteriorating performance of the tubewells. Similar trend was noticed in the yields of major crops.

An analysis of the initial and subsequent performance of the SCARPS indicates that so long as tubewell pumpage maintained a balance against recharge, waterlogging and salinity condition improved thus raising the economic returns. However when this balance between recharge and discharge components got upset waterlogging and salinity conditions started redeveloping. The main reasons for this reversal are increased provisions of canal supplies from the surface storage, reduced pumpage and decreased utilization as a result of hours lost from electrical/mechanical faults and lack of proper maintenance. Measures needed to improve the efficiency of performance include (i) proper maintenance, cleaning and chlorination of the wells to kill and prevent the growth of bacteria which choke the gravel pack and the strainer slot (ii) timely rehabilitation of tubewells when the specific capacity reduction ranges from 25% to 50%.

## 1. INTRODUCTION

In order to compile a technical paper on "Operation and Maintenance of completed projects" detailed data was required for a particular project to record its case history. This information/data includes utilization hours of the tubewells, hours lost due to mechanical, electrical faults, number of tubewells rehabilitated/replaced, cost involved in maintenance and repair of the tubewells etc. This type of information is available with the Irrigation Departments of the respective Governments who are operating agencies of the completed projects. SCARPS Monitoring Organization is carrying out monitoring and evaluation of the SCARPS viz-a viz their planned targets. The detailed information needed for preparing case history of a project is not available with this organization. Efforts were made to get some information from the irrigation department but could not be collected in such a short period of time. Under the circumstances, utilizing the data already available with this organization, an attempt has been made to highlight the operation and maintenance of some of the completed SCARPS, their performance with respect to depth to water table, soil salinity, water quality, cropping intensity and yields etc.

In Pakistan the problem of waterlogging and salinity began to develop soon after the introduction of canal irrigation in the Indus Plain. By early fifties of the present century about 25% irrigated area in the country developed water table within 150 cms of ground surface and the soils in approximately 22% area developed moderate to severe saline conditions. To control this twin menace as well as to improve agriculture, different drainage and reclamation measures were adopted which included vertical, surface drainage as well as the tile drains. The proposed remedies included lowering of water table in high water table areas and leaching and flushing

out salts from the root zone. By June 1988 the Government of Pakistan had completed the construction of 36 Salinity Control and Reclamation Projects (SCARPS) covering gross commanded area of 3.76 million hectares while work on 14 projects covering another 3.36 million hectares was under progress. Till the end of June, 1988 construction of some 11,500 irrigation tubewells, 1723 drainage tubewells and an equal No. of replacement tubewells, more than 200 million cubic meters of surface drains and 5074 hectares of tile drains had been completed.

With the adoption of reclamation measures and introduction of SCARP programme a lot of improvement was observed in lowering of watertable and removal of salinity in the earlier stages of development. However, with the passage of time, the pace of progress set forth initially dwindled and could not be maintained at the same speed. In a number of cases the envisaged target were not achieved mainly because of the difficulties encountered during operation and maintenance of these SCARPS. SCARPS-I,II,III & IV in the province of Punjab, Peshawar in NWFP and Khairpur & North Rohri in Sind have been selected Fig. 1 for detailed evaluation and to investigate the reasons for their retarded performance.

## **2. OBJECTIVES OF SCARPS**

The basic concepts on which the SCARPS have been designed are :-

- (i) To lower water table in waterlogged area and to rescue the land for development.
- (ii) To control and remove salinity in the SCARP areas.
- (iii) To bring the areas thus rescued under crop by means of extra supplies made available from tubewells in fresh ground water zones or by means of extra surface supplies wherever available in saline zones.
- (iv) To improve the agricultural out-put in the SCARPS by better farm management, use of farm inputs, thereby raising the intensity of agriculture and yields of crops.

The above mentioned objectives were to be achieved by means of vertical or horizontal drainage provided by the tubewells, surface or tile drains or a combination of both these methods.

The salient results with respect to the parameters like tubewell performance, depth to water table, soil salinity and agricultural development of some prominent SCARPS in different provinces are discussed in the following pages.

## **3. TUBEWELL PERFORMANCE**

The performance of the tubewells can be judged from the following parameters :-

- (i) The pumping capacity and capability of the tubewell in delivering the design discharge.
- (ii) Specific capacity of the tubewells.
- (iii) Utilization of tubewells.

The pumping capacity of the tubewells is affected by (i) lowering of water table, (ii) poor maintenance of the pumping equipment and (iii) deterioration of the well screens while the specific capacity is entirely a function of the condition of the well screen and the gravel pack. The general causes recognized for reduction in the specific capacity are corrosion and incrustation of well screens, choking of gravel pack due to invasion of fine material and its conglomeration due to precipitation of calcium carbonate and bacterial activity. Whenever a well deteriorates in performance apart from reduction in discharge it starts giving out sand due to damage of the well screen. The indication of sand beyond the permissible limit renders the well unfit for operation. Other factor which affects the total efficiency of the well is its utilization which is dependant upon the need for irrigation water, frequency of break down due to mechanical or electrical faults and to some extent the quality of the pumped water.

The pumpage, median specific capacity and utilization of SCARPS-I, II, III, & IV in Punjab, Peshawar in NWFP and Khairpur and North Rohir in Sind is given in Table-1 to 7 and Fig. 2 to 9. Designed and the maximum pumpage attained by the tubewells of different SCARPS with an average annual utilization factor is as below :

Name of SCARP	Year of commission	Year of Maximum pumpage	Maximum Pumpage Thousand	Designed Pumpage Hec. Meter	Average Annual Utilization (Percent)
SCARP-I	1960-61	1962-63	340	185	67
SCARP-II	1971-72	1974-75	318	275	43
SCARP-III	1971-72	1974-75	206	221	46
SCARP-VI	1971-72	1974-75	123	166	47
N.W.F.P.					
Peshawar	1974-75	1979-80	7	8	45
S I N D					
Khairpur	1967-68	1971-72	65	55	39
North Rohri	1973-74	1982-83	92	92	28

The pumpage was maximum in the early years of the commissioning of the tubewells but subsequently the pumpage dropped in almost all the SCARPS. The drop in pumpage has resulted mainly from the deterioration of the tubewells. Similar trend was observed in median specific capacity of the SCARP tubewells.

#### 4. CANAL SUPPLIES

Yearwise Canal Supplies in different SCARPS are indicated in Table-1-7. It is observed that the supplies rose generally in SCARP areas after releases from Managla and Tarbela storages.

#### 5. DEPTH TO WATER TABLE

Contribution by SCARPS in controlling water table is given in Table 8 & Fig. 10-11, which shows that in SCARP-I, the area underlain by 0-150 cms depth to water table was 13.5% in 1961. After coming into operation of project tubewells the waterlogged area was totally eliminated in the project in 1965 and it remained so till 1972. Thereafter waterlogging again started increasing due to reduction in pumpage on account of the deterioration of project tubewells and enhanced canal supplies. In SCARP-II, the area underlain by 0-150 cms depth to water table in the pre-project (1964) was 11% which decreased to 0.8% by 1975 after the operation of project tubewells. However it showed a trend of increase afterwards to a maximum of 16.3% in 1982 and again reduced to 1.2% in 1988. The main reasons of rise in water table were less pumpage and comparatively more canal supplies/rainfall. In SCARP-III, the area having 0-150 cms depth to water table was 41.2% in the pre-project period i.e. 1969. After commencement of the project, water-logging conditions improved considerably. The area under 0-150 cms depth to water table reduced from 41.2% to 6.2% in 1975. Thereafter, the situation started deteriorating on account of the reduction in tubewell pumpage and increase in canal supplies. In SCARP-IV, only 0.2% area was waterlogged in the base year (1969). With the operation of the project, the waterlogging conditions started improving and the waterlogging was controlled completely by 1974. From 1975 through 1988 it fluctuated between 0 to 1.1%. In SCARP Khairpur, the waterlogged area before the operation of the project was 29.7%. After coming into operation of the project tubewells high water table conditions improved considerably. The disaster area (0-150 cms) reduced to 16.0% in 1980. Thereafter, the waterlogging conditions started deteriorating due to poor performance of project tubewells. However, in 1988 the area underlain by 0-150 cms depth to water table has shown a downward trend and decreased to 21.3%. In SCARP North Rohri, the waterlogged area in 1976 was 1.1%. With the operation of SCARP tubewells it declined to 0.2% in 1980. Thereafter, the area under waterlogging again started rising and reached 6% in 1988 mainly due to decline in tubewell pumpage. Before coming into operation of the SCARP Peshawar, the waterlogged area in the project was 17.2%. With the operation of tubewells the waterlogging conditions gradually improved as the waterlogged area reduced to 11.9% in 1982. Thereafter, it again started rising and reached the pre-project level in 1988 due to comparatively more canal supplies. It may be stated here that rise in water table has been noticeable even in SCARP areas during the past few years. In this connection it may be stated that the SCARP pumpage is meant to control waterlogging under normal conditions of recharge envisaged at the planning stage. Under more than normal recharge conditions temporary rise in water table in SCARP areas is expected especially due to

decline in tubwell pumpage under deteriorated conditions of the wells and should not be taken as a failure on the part of SCARPS to control water table.

## 6. SOIL SALINITY

The application of enhanced irrigation supplies after coming into operation of project tubewells have brought about a lot of improvement in the salinity and sodicity status of deteriorated soils. SCARP-wise changes in the surface and profile salinities observed upto 1986-87 are stated hereunder :-

### 6.1 Surface salinity

Surface salinity status of SCARPS-I to IV, in the Punjab, Peshawar in NWFP, Khairpur and North Rohri in Sind, according to different salinity survey periods is given in Table-9. The data indicates that surface salinity has considerably decreased in SCARP areas. In SCARP-I, salt free area (S1) increased from 64 percent in 1954-65 to 86 percent in 1977-78 but decreased to 77 percent in 1981-82. In SCARP-II, (S1) area increased from 62 percent in 1953-65 to 83 percent in 1977-78. In the latest survey of 1983-85 a further increase of 2 percent in salt free area was observed. In SCARP-III, (S1) area increased from 55 percent to 74 percent in 1977-78. However, a decrease of 2 percent was found according to 1982-83 survey. In SCARP-IV, (S1) area increased from 40 percent in 1953-65 to 68 percent in 1976-80. There is a further increase of 10 percent as per latest survey. In SCARP Peshawar, (S1) area increased from 67% during 1971-75 to 75% in 1977-78. In SCARP Khairpur (S1) area increased from 24% during 1953-54 to 70% in 1977-78 while in North Rohri it increased from 46% to 76%. There is a decreasing trend in (S1) area in SCARP-I & III during the latest survey which can be attributed to (1) gradual rise in water table due to closure of brackish quality tubewells (2) gradual decrease in pumpage due to reduction in discharge of tubewells in most of the SCARPS and (3) use of questionable water without suitable mixing with canal water. Surface salinity status in different SCARPS is graphically represented in Fig. 12 & 13.

### 6.2 Profile salinity

Profile salinity status is given in Table-10. In SCARP-I, non-saline non-sodic (NS-NS) profiles increased from 34 percent in 1962-63 to 70 percent in 1977-78 but later decreased to 60 percent in 1981-82 due to rise in water table. In SCARP-II, non-saline non-sodic soil profiles increased from 58 percent in 1962-65 to 78% in 1977-78. In the latest survey a further increase of 1 percent has been observed. In SCARP-III, non-saline non-sodic profiles increased from 49 percent in 1962-63 to 69% in 1977-78 but reduced to 64 percent in 1982-83. In SCARP-IV, non-saline non-sodic profiles increased from 25 percent in 1962-65 to 62 percent in 1977-78 and registered a further increase of 2 percent in the latest survey. In SCARP Peshawar, Khairpur and North Rohri, profile salinity was not appraised earlier and hence no comparison can be made. However, the reasons for reduction of non-saline non-sodic soil profiles in

SCARP-I & III and increase in saline/sodic profiles have already been given under surfar salinity, Profile salinity is represented graphically in Fig. 14 & 15.

## **7. WATER QUALITY**

Yearwise changes in the water quality of different SCARPS is indicated in Table-11 and Fig. 16 (i-vii). There has been deterioration in water quality from 3 to 10% in SCARP-I to IV (Punjab) and 4 to 6% in Khairpur and North Rohri (Sind). There is no significant change in Peshawar SCARP (NWFP).

## **8. CROPPED AREA/CROPPING INTENSITY**

The SCARP-wise development of cropped area/cropping intensity is summarised below and given in Table-12 and 13 and Fig. 17 and 18.

### **SCARP-I**

The cropped area increased from 370.5 thousand hectares in '1959-60 to 531.9 during 1987-88 against the ultimate target of 553.9 thousand hectares. The cropping intensity increased from 80.2 percent in the base year to the maximum of 122.5 percent during 1980-81. Increase in cropped area was rapid between 1960-61 to 1965-66 due to increase in availability of canal and tubewell supplies. During 1965-66 to 1975-76 rate of increase is slow because of inadequate supplies due to deterioration in performance of project tubewells. From 1975-76 to 1978-79, this rate has increased due to increased canal supplies, more rainfall and pumpage. Thereafter, a gradual declining trend has been observed upto 1987-88 mainly due to rise in water table, less pumpage and rainfall over the years.

### **SCARP-II**

The cropped area increased from 569.6 thousand hectares in 1972-73 to 730.2 thousand hectares in 1987-88 against the planned target of 856.6 thousand hectares. Cropping intensity increased from 94% to the highest value of 123% during 1985-86. However, it declined to 121% in 1987-88.

### **SCARP-III**

The cropped area during the base year in SCARP-III was 308.2 thousand hectares which rose to 478.0 during 1987-88 against the envisaged target of 490.4 thousand hectares. The cropping intensity was 79.5% in the base year which increased to the maximum value of 128.2% during 1986-87. Thereafter, it dropped to 128.3% during 1987-88.



## **SCARP-IV**

The cropped area 139.5 thousand hectares increased to 230.3 during 1987-88 against the planned target of 320.2 thousand hectares. The cropping intensity rose to the maximum of 113.5% during 1986-87 as compared with 65.1% in the base year. In 1987-88 it declined to 107.4%. The cropped area has steadily increased on account of overall increased irrigation supplies.

## **SCARP Khairpur**

The cropped area rose from 137.8 thousand hectares in the base year to 184.2 in 1987-88 against the ultimate target of 234.3 thousand hectares. The cropping intensity which was 89.5% in the base year increased from 89.5% in the base year to the maximum of 137.5% during 1981-82. Later it dropped to 119.6% during 1987-88 due to short irrigation supplies and waterlogged conditions.

## **SCARP North Rohri**

The cropped area rose from 246.0 thousand hectares during the base year to 304.1 during 1987-88 against the ultimate target of 416.3 thousand hectares whereas cropping intensity from 88.6% in the base year to the highest of 117.7% during 1984-85. However it dropped to 109.6% during 1987-88. There was no remarkable increase in cropping intensity since base year due to shortage of supplies, less rainfall and waterlogged conditions especially in the later years.

## **SCARP Peshawar**

In SCARP Peshawar, cropped area increased from 59 thousand hectares in the base year to 73.1 thousand hectares during 1987-88 against the planned target of 75.7 thousand hectares. The cropping intensity increased from 138.1% to 170% during the same period. There was very slow increase in cropped area due to erratic as well as short irrigation supplies and high water table conditions.

## **9. CROP YIELDS**

SCARP-wise development of crop yields is briefly described hereunder Table-14 (Fig. 19-i to 19-vii).

### **SCARP-I**

The yields of sugarcane, rice, cotton and wheat were 30.4, 1.4, 0.6 and 1.1 metric tons per hectare in the base year which rose to the maximum of 49.3, 2.3, 1.1 and 2.2 metric tons per hectare against

## **SCARP-II**

The yields of almost all the crops have increased over the base year except sugarcane. The base year yield of sugarcane seems to be unrealistic. The yields of sugarcane, rice, cotton and wheat increased from 41.0, 1.5, 0.6 and 1.4 metric tons per hectare in the base year to the maximum of 48.6, 2.4, 1.0 and 2.1 metric tons per hectare against their respective targets of 46.1, 2.3, 1.1 and 2.3 metric tons per hectare. The yields of major crops remained almost stagnant due to short and erratic irrigation supplies and waterlogged conditions.

## **SCARP-III**

The yields of major crops i.e. sugarcane, rice, cotton and wheat increased from 29.5, 1.2, 0.7 and 1.2 metric tons per hectare in the pre-project level to maximum of 37.5, 2.2, 1.7 and 1.9 metric tons against the target values of 69.2, 2.8, 1.4 and 2.3 respectively. However, the yields of sugarcane, rice and wheat declined to 30.0, 2.2 and 1.7 metric tons per hectare during 1987-88. The yields of sugarcane, wheat and cotton have shown no rising trend due to general rise in water table. However, the yield of rice has shown a trend of regular increase from base year to 1984-85 thereafter it declined due to short irrigation supplies.

## **SCARP-IV**

The yields of major crops in the project area i.e. sugarcane, rice and wheat increased from 27.7, 1.3 and 1.1 metric tons per hectare in the base year to the maximum of 45.6, 2.2 and 2.1 metric tons per hectare against the target values of 69.2, 3.2 and 2.8 metric tons per hectare respectively. However, during 1987-88 the yields of these crops declined to 38.0, 1.9 and 1.7 metric tons per hectare respectively. The rate of increase in yields is generally slow due to shortage of irrigation supplies. The decline in yields of sugarcane and rice during 1987-88 was due to less rainfall. The yield of cotton has shown no increase due to pests attack and short irrigation supplies.

## **SCARP Khairpur**

The yields of sugarcane, rice, cotton and wheat rose from 18.4, 0.9, 0.6 and 1.2 metric tons per hectare in the base year to the maximum of 43.8, 2.1, 1.3 and 2.2 metric tons per hectare against the target value of 85.3, 5.7, 2.5 and 5.1 metric tons per hectare respectively.

## **SCARP North Rohri**

Before the commencement of the project, the yields of sugarcane, rice, cotton and wheat were 35.9, 1.4, 0.4 and 1.6 metric tons per hectare. With the operation of SCARP, the yields increased to the maximum of 73.8, 3.7, 1.4 and 2.8 metric tons per hectare against the envisaged value of 85.3, 5.7, 2.5 and 5.1 metric tons per hectare

respectively. However, during 1987-88 yields of sugarcane, rice and wheat increased sufficiently due to increase in canal supplies.

### **SCARP Peshawar**

The yields of sugarcane, rice, cotton and wheat were 41.4, 1.3, 0.6 and 1.1 metric tons per hectare during the base year. These increased to the maximum of 44.3, 2.8, 1.4 and 2.4 metric tons per hectare against the ultimate target of 97.0, 7.0, 1.8 and 6.0 metric tons per hectare respectively. Table-15 indicates that the yields of sugarcane, rice and wheat have shown nominal increase whereas the yield of cotton has gone down even from the base year but to waterlogged conditions.

## **10. PERFORMANCE EVALUATION OF SCARPS**

A performance evaluation of the initial years of implemented SCARPs reveals that water table in these areas declined and a progressive reclamation of the soils from surface and profile salinities took place as the tubewells were operated. These improvements, coupled with supplemental irrigation supplies from tubewells, increased cropping intensities and crop yields to the extent even more than that envisaged in the original plans. In economic terms, the investment produced high, positive, benefit cost ratios, over the pre-project production base. However an overall upto date evaluation of the performance of these SCARPS and their comparison with the planned targets bring out that although their initial performance has been very encouraging yet their aggregate efficiency has not been of a high order and that some of the expectations cherished by planners have not been realized. It has become further evident that the phenomenon of improvement in these SCARPS continued only for about 10-12 initial years, remained steady for a couple of subsequent years and thereafter started declining.

An analysis of the initial and subsequent performance of SCARPS indicates that so long as tubewells pumpage maintained a balance against recharge (mainly) from canal seepage and water supplied to fields, both waterlogging and salinity remained under control and agro-economic returns rose steadily. However, as the balance between recharge and discharge component got upset, water table in these areas started rising. As a result thereof waterlogging and salinity conditions started redeveloping causing a decline in the cropping intensities, crop yields and economic returns.

There are quite a few reasons which are responsible for the subsequent upsetting of water balance and the consequent decrease in the effectiveness of SCARPS in these areas. The main among these are :

- \* Increased provision of canal supplies in SCARP areas from surface storage viz-a-viz design values.
- \* Reduced pumpage from SCARP wells due to their deterioration.

- \* Decreased utilization of SCARP tubewells due to hours lost from electrical, mechanical, operational faults and shut downs.

## 11. DEFICIENCIES IN OPERATION AND MAINTENANCE

The maintenance of the public tubewells in the SCARP areas has not been up to the standard and leaves much room for improvement and is to some extent responsible for not achieving the planned objectives. It has been seen that the minor deterioration of wells in respect of reduction of discharge and in specific capacity are ignored with the result that these deteriorations go on developing till such time the wells attain the stage of advanced deterioration and its recovery becomes doubtful.

The reduction in discharge due to different defects and utilization hours for the six scarps selected for case studies is tabulated in table 7(a) and table 7(b) for which the data has been provided by T&GWM directorate of SMO. From the data given, the following deficiencies in operation and maintenance of the tubewells have been observed.

### (i) Less Utilization .

This deficiency is common in almost all the SCARPs. The tubewells are not being operated according to the planned utilization factors which has resulted in less pumpage and has ultimately affected the output of the SCARPS in not achieving the planned cropping intensities and crop yields. Even in some areas the basic requirement of lowering the water table has not been met.

### (ii) Lack of Proper Maintenance .

One of the reasons for low utilization of the SCARP tubewells is the lack of proper maintenance of the tubewells. It has been experienced while carrying out monitoring of the SCARPS that once a tubewell is put into operation it is never cleaned unless and until it develops a defect and is closed down. There are instances where the cleaning of the pumps has not been done for the last 10 years on a tubewell and even in case a motor of a tubewell is burnt, it is replaced after inordinate delay. The other most important aspect in respect of maintenance which has not been attended to is the fact that gravel is not periodically fed during the operation of tubewell. It appears that the supervisory staff of the operating agencies are not aware of the importance of this aspect of maintenance. During the course of operation of a tubewell there should be constant feeding of gravel material in the initial period and this feeding of gravel pack should continue though in small quantities in advanced stage of operation of the tubewells and sufficient water may also be added over the filter material to eliminate bridging of the gravel. Because of neglect in this respect many tubewells have started giving sand because with the sinking of the gravel pack around the strainer some portions are exposed directly to the soil.

It has also been observed that in certain cases notice of excessive consumption of shrouding material was not taken, with the result that sudden sinking of tubewells has occurred. It usually happens due to formation of large cavity below a clay layer.

**(iii) Lack of Supervision by the Operating Agencies :**

It has been seen that one of the reasons that some of the SCARPS have not attained the planned objectives is due to financial constraint. The operators of the tubewells do not take proper care and sometimes the tubewells are operated by the farmers resulting in mis-handling and damage to the tubewells. It has also been seen that the damaged parts like electric motors are not replaced and repaired and the tubewells remain idle for a long time.

## **12. RECOMMENDATIONS**

The following measures may be adopted to ensure proper maintenance of the SCARP tubewells, and to achieve the desired benefits from the completed projects.

- (i) Cleaning and chlorination of the well periodically so as to kill and prevent the growth of bacteria and ultimately the bacterial slime which chokes the gravel pack as well as the strainer slots.
- (ii) Timely rehabilitation of tubewells (when the specific reduction ranges from 26 percent to 50 percent) which have deteriorated and require renovation.
- (iii) Timely replacement of tubewells when the specific capacity reduction is over 50 percent.
- (iv) An operator must be fully trained for operation of the tubewell, protection and maintenance of equipment and able to detect any expected operational defect.
- (v) Executive Engineer (Work shop) of the project may be entrusted to train not only the operators but overseers and Sub Divisional Officers also.
- (vi) Every one concerned with O&M of tubewells may be provided with a copy of the Manual for Operation and Maintenance of SCARP tubewells and must be fully familiar with its contents.
- (vii) A tubewell is required to run for 20 hours (from 9-PM to 5-PM) daily and even on gazetted holidays. It is therefore suggested that two operators for each tubewell may be employed, who will also arrange for themselves the rest for the working holidays with the permission of the supervisory staff.
- (viii) Project office may have a technical log book for each tubewell containing all details about formation, construction of tubewells, scientific information and past history of the facts and defects of the tubewells.

- (ix) Water quality of the tubewell effluent may be checked off and on to avoid use of saline water beyond permissible limits.
- (x) In view of the increased provision of canal supplies in SCARPS areas from surface storage, it is imperative to run the tubewells at least according to the planned utilization factor for the project to keep the watertable at the desired level.
- (xi) The pumping capacity of the sick tubewells (giving excessive sand) may be reduced to control sand yield upto 10 - 20% of the present values to avoid further deterioration of the tubewells.
- (xii) Efforts be made to run tubewells continuously for the number of hours assigned to each. Stoppage during operational hours should be the minimum. To get maximum output from the reduced wells, possibility of increasing number of operation hours per day may also be examined.

**TABLE - 1**  
**PUMPAGE, MEDINA SPECIFIC CAPACITY, UTILIZATION(%)**  
**AND CANAL SUPPLIES OF DIFFERENT SCARPS**  
**PUNJAB**

**SCARP-I**

C.C.A = 0.462 million hectare

No. of tubewells = 2074

Year	Pumpage (Thousand H.M.)	Median specific capacity (lpm/dm)	Utilization Hours (percent)	Canal supplies (Thousand Hect.metre.)	Remarks.
Designed=185					
1960-61	212	-	-		
1961-62	320	-	-		
1962-63	340	-	67		
1963-64	317	-	67		
1964-65	287	-	67		
1965-66	315	-	69		
1966-67	191	-	50		
1967-68	224	-	60		
1968-69	242	-	66	310	Less utilization is due to Electrical & Mechanical Faults.
1969-70	240	87	73	317	
1970-71	239	84	77	281	
1971-72	206	76	70	275	
1972-73	201	79	69	343	
1973-74	177	75	62	298	
1974-75	176	64	66	314	
1975-76	170	73	67	299	
1976-77	158	73	62	330	
1977-78	171	100	61	364	
1978-79	193	87	58	353	
1979-80	195	87	59	355	
1980-81	160	87	50	383	
1981-82	181	87	54	259	
1982-83	160	85	51	320	
1983-84	156	72	54	271	
1984-85	192	75	61	280	
1985-86	183	65	59	382	
1986-87 )	192				
1987-88 )	195	61	63	312	

Source: i) SCARPS Monitoring Organization, WAPDA, Lahore.  
 ii) Irrigation & Power Department, Punjab

**TABLE - 2**  
**PUMPAGE, MEDIAN SPECIFIC CAPACITY, UTILIZATION(%),**  
**AND CANAL SUPPLIES OF DIFFERENT SCARPS**

**SCARP-II**

C.C.A = 0.827 Million Hectare

No. of tubewells = 2205

Year	Pumpage (Thousand H.M.)	Median specific capacity (lpm/dm)	Utilization Hours (Percent)	Canal supplies (Thousand Hect.metre.)	Remarks.
Designed=275					
1971-72	195	-	-	224	
1972-73	197	-	-	228	
1973-74	189	-	-	208	
1974-75	318	-	43	291	
1975-76	278	109	43	292	
1976-77	237	113	43	351	
1977-78	226	109	39	380	
1978-79	238	N.A.	39	322	
1979-80	260	103	46	339	
1980-81	251	112	43	304	
1981-82	242	104	45	296	
1982-83	235	95	44	374	
1983-84	270	92	46	285	
1984-85	275	94	56	273	
1985-86	237	87	56	327	
1986-87	-	-	-	330	
1987-88	-	-	-	331	

Source: i) SCARPS Monitoring Organization, WAI-DA, Lahore.  
 ii) Irrigation & Power Department, Punjab.



**TABLE - 3**  
**PUMPAGE, MEDIAN SPECIFIC CAPACITY, UTILIZATION(%)**  
**AND CANAL SUPPLIES OF DIFFERENT SCARPS**

**SCARP-III**

G.C.A = 0.425 Million Hectare

No. of tubewells = 1635

Year	Pumpage (Thousand H.M.)	Median specific capacity (lpm/dm)	Utilization Hours (Precent)	Canal supplies (Thousand Hect.metre.)	Remarks.
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Designed=221

1971-72	100	-	-	313	
1972-73	121	-	-	384	
1973-74	163	115	-	382	
1974-75	206	121	-	294	
1975-76	178	112	-	374	
1976-77	142	104	36	467	
1977-78	190	101	N.A.	409	
1978-79	183	95	49	400	
1979-80	172	95	46	499	
1980-81	178	69	49	451	
1981-82	200	70	61	392	
1982-83	189	82	54	432	
1983-84	163	54	51	412	
1984-85	173	94	56	420	
1985-86	159	66	54	350	
1986-87	111 )	94	55	534	
1987-88	129 )			387	

Source: i) SCARPS Monitoring Organization, WAPDA, Lahore.  
 ii) Irrigation & Power Department, Punjab.

**TABLE - 4**  
**PUMPAGE, MEDIAN SPECIFIC CAPACITY, UTILIZATION(%)**  
**AND CANAL SUPPLIES OF DIFFERENT SCARPS**

**SCARP-IV**

C.C.A = 0.214 Million Hectare

No.of tubewells = 940

Year	Pumpage (Thousand H.M.)	Median specific capacity (lpm/dm)	Utilization Hours (Percent)	Canal supplies (Thousand Hect.metre.)	Remarks.
Designed=166					
1971-72	74	=	-	74	
1972-73	88	137	-	88	
1973-74	118	121	-	68	
1974-75	123	104	47	78	
1975-76	118	94	46	80	
1976-77	107	97	44	61	
1977-78	101	88	41	95	
1978-79	102	85	40	83	
1979-80	103	85	43	105	
1980-81	85	73	39	82	
1981-82	94	72	45	86	
1982-83	94	76	46	66	
1983-84	84	73	41	85	
1984-85	94	76	47	90	
1985-86	94	77	45	82	
1986-87	105	75	52	83	
1987-88	107			83	

Source: i) SCARPS Monitoring Organization, WAPDA, Lahore.  
 ii) Irrigation & Power Department, Punjab.

**TABLE - 5**  
**PUMPAGE, MEDIAN SPECIFIC CAPACITY, UTILIZATION(%)**  
**AND CANAL SUPPLIES OF DIFFERENT SCARPS**  
**N.W.F.P.**  
**SCARP-PESHAWAR**

C.C.A. = 0.074 Million Hectare

No. of tubewells = 155

Year	Pumpage (Thousand H.M.)	Median specific capacity (lpm/dm)	Utilization Hours (Percent)	Canal supplies (Thousand Hect.metr.)	Remarks.
	Designed=8				
1974-75	2	=	=	88	
1975-76	3	-	-	74	
1976-77	2	-	-	82	
1977-78	4	-	42	90	
1978-79	6	-	39	78	
1979-80	7	-	45	90	
1980-81	7	26	41	80	
1981-82	7	24	42	90	
1982-83	6	24	36	94	
1983-84	6	20	38	101	
1984-85	6	21	37	84	
1985-86	6	22	39	86	
1986-87	7	22	40	52	
1987-88	7	16	45	58	

Source: i) SCARPS Monitoring Organization, WAPDA, Peshawar  
 ii) Irrigation & Power Department, NWFP.

**TABLE - 6**  
**PUMPAGE, MEDIAN SPECIFIC CAPACITY, UTILIZATION(%)**  
**AND CANAL SUPPLIES OF DIFFERENT SCARPS**  
**SIND**  
**SCARP-KHAIRPUR**

C.C.A = 0.154 Million Hectare

No.of tubewells = 540

Y e a r	Pumpage (Thousand H.M.)	Median specific capacity (lpm/dm)	Utilization Hours (Percent)	Canal supplies (Thousand Hect.metre.)	Remarks.
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Designed=55

1967-68	20	-	-		
1968-69	45	-	-	252	
1969-70	41	-	-	213	
1970-71	60	-	-	210	
1971-72	65	45	39	206	
1972-73	56	-	-	231	
1973-74	57	-	-	226	
1974-75	33	-	-	201	
1975-76	45	43	-	241	
1976-77	32	45	-	225	
1977-78	48	45	-	234	
1978-79	42	43	38	216	
1979-80	34	42	30	236	
1980-81	33	44	30	224	
1981-82	35	41	29	230	
1982-83	34	44	30	235	
1983-84	46	41	38	228	
1984-85	36	49	26	235	
1985-86	39	41	25	205	
1986-87	40	41	25	173	
1987-88	30	44	23	236	

Source: i) SCARPS Monitoring Organization(South),Hyderabad  
 ii) Irrigation & Power Department, Sind

**TABLE - 7**  
**PUMPAGE, MEDIAN SPECIFIC CAPACITY, UTILIZATION(%)**  
**AND CANAL SUPPLIES OF DIFFERENT SCARPS**

**SCARP-NORTH ROHRI**

C.C.A= 0.279 Million Hectare

No.of tubewells = 1192

Year	Pumpage (Thousand H.M.)	Median specific capacity (l.p./dm)	Utilization Hours (Percent)	Canal supplies (thousand hect.metre.)	Remarks.
	Designed = 92				
1973-74	77	-	-	-	
1974-75	60	-	-	-	
1975-76	69	84	-	355	
1976-77	76	88	25	358	
1977-78	71	76	19	362	
1978-79	57	68	22	358	
1979-80	38	71	39	362	
1980-81	49	76	60	359	
1981-82	91	70	30	355	
1982-83	92	67	23	360	
1983-84	74	62	N.A.	362	
1984-85	79	59	N.A.	348	
1986-87	85	60	29	319	

Source: i) SCARPS Monitoring Organization (South), Hyderabad.  
 ii) Irrigation & Power Department, Sind.

TABLE - 7 (A)  
STATEMENT SHOWING THE CURRENT TEST POSITION OF SCARPS  
PUNJAB

PUNJAB									
Sr. No.	Name of SCARP	Total tested tubewells	Reduction in discharge more than 100 gpm due to			Sand Content		Wire to water efficiency less than 30% due to friction in pumping unit No./%	UTILIZATION HOURS (percent)
			Screen problem	Pump problem	Lowering in W.T.	Upto 100 ppm	More than 100 ppm		
			No./%	No./%	No./%	No./%	No./%		
1.	SCARP-I (1986-88)	1389	813/58.5	371/26.7	277/19.9	3/0.33	2/0.14	149/10.7	63
2.	SCARP-II (F.Z.) (1986-88)	1623	913/56.3	1139/70.2	297/18.3	19/1.17	6/0.37	91/5.6	-
3.	SCARP-III (F.Z.) (1986-88)	1168	1001/85.7	577/49.4	392/33.6	173/14.81	13/1.11	194/16.6	55
4.	SCARP-IV (1986-88)	732	550/75.1	360/49.2	294/40.2	15/2.05	12/1.64	16/2.2	52

\* Total No. of tubewells/Percentage increased because the tubewells have been counted/repeated in different problems.

**TABLE - 7 (B)**  
**STATEMENT SHOWING THE CURRENT TESTS POSITION OF SCARPS**  
**SINDH**

Sr. No.	Name of SCARP	Total tested tubewells	Reduction in discharge due to screen problem, pump problem and lowering in W.T.			Sand contents more than 50 ppm No./%	Wire to water efficiency less than 30% due to friction in pumping unit (No./%)	UTILIZATIO HOURS PERCENT
			1-30% No./%	31-50% No./%	More than 50% No./%			
1.	SCARP Khairpur		195/ 43.4	200/ 44.5	34/ 7.6	1/ 0.3	30/ 6.7	25
2.	SCARP North Rohri		307/ 54.0	95/ 16.7	47/ 8.3	112/ 19.0	32/ 5.9	29

**N.W.F.P.**

Sr. No.	Name of SCARP	Total	Reduction in discharge since acceptance test due to			Sand contents more than 50 ppm No. / %	Wire to water efficiency less than 30% due to friction in pumping unit No. / %	UTILIZATION HOURS PERCENT
			Screen problem No./%	Pump problem No./%	Lowering in W.T. No./%			
3.	Peshawar SCARP		19/ 14.5	6/ 4.7	7/ 5.2	N.A.	N.A.	40

TABLE - 8  
SCARP-WISE AREAS UNDER 0 - 150 CM DEPTH TO WATER TABLE

Years	000-hectare/percent						
	SCARP-I	SCARP-II	SCARP-III	SCARP-IV	SCARP-Pesha- war	SCARP Khairpur	SCARP North Rohri
1960	-	-	-	-	-	53.0/29.7	-
1961	66.4/13.5	-	-	-	-	-	-
1962	-	73.2/11.0	-	-	-	-	-
1963	0	-	-	-	-	-	-
1964	0	-	-	-	-	-	-
1965	0	-	-	-	-	-	-
1966	0	-	-	-	-	-	-
1967	0	-	-	-	-	-	-
1968	0	-	-	-	-	-	-
1969	0	-	189.8/41.2	0.44/0.2	-	-	-
1970	0	-	-	-	-	-	-
1971	0	-	-	-	-	-	-
1972	0	-	-	0.00/0.0	-	-	-
1973	2.0/0.4	-	-	1.60/0.7	-	-	-
1974	4.9/0.1	-	46.1/10.0	0.00/0.0	-	-	-
1975	4.9/1.0	5.2/0.8	28.7/6.2	2.43/1.1	-	-	-
1976	12.5/2.5	50.2/7.5	50.2/10.9	0.40/0.2	15.8/17.2	79.7/44.6	3.6/1.1
1977	10.9/2.2	61.9/9.3	55.4/12.0	0.81/0.4	15.4/16.8	44.5/24.9	0.00/0.0
1978	6.1/1.2	59.1/8.9	88.2/19.2	0.00/0.0	11.3/12.3	34.0/19.0	2.0/0.6
1979	15.8/3.2	99.2/14.9	128.3/27.9	0.40/0.2	11.7/12.7	32.8/18.4	2.4/0.7
1980	5.7/1.2	43.7/6.6	105.6/22.9	1.62/0.7	11.3/12.3	27.9/15.6	0.8/0.2
1981	19.8/4.0	45.7/6.8	119.0/25.8	0.40/0.2	13.8/15.0	54.2/30.4	2.8/0.9
1982	44.1/8.9	108.9/16.3	59.1/12.8	0.40/0.2	10.9/11.9	100.4/56.2	10.1/3.1
1983	25.5/5.3	99.6/14.9	66.8/14.5	0.40/0.2	15.4/16.8	68.8/38.5	10.1/3.1
1984	3.6/0.7	38.4/5.8	40.5/8.8	0.0/0.0	15.1/16.4	84.0/47.1	20.0/6.3
1985	0.5/0.1	31.5/4.7	7.0/1.5	0.00/0.0	11.7/12.7	76.1/42.6	14.0/4.4
1986	13.0/2.6	67.0/10.0	46.0/9.6	0.50/0.2	11.1/12.1	69.3/38.8	8.0/2.5
1987	11.0/2.2	47.0/7.0	106.0/23.0	1.00/0.4	13.1/14.3	79.1/44.3	12.5/3.9
1988	2.0/0.4	8.0/1.2	69.0/15.0	0.00/0.0	15.7/17.1	38.2/21.3	20.0/6.0

Source: SCARPS Monitoring Organization, WAPDA, Lahore.

- = Data not available



**TABLE - 9**  
**SURFACE SALINITY IN SCARPS**

SCARPs	Agency	Period	Percent of area under various salinity classes				Misc:
			Non-Saline S <sub>1</sub>	Slightly Saline S <sub>2</sub>	Moderately Saline S <sub>3</sub>	Strongly Saline S <sub>4</sub>	
<u>PUNJAB</u>							
SCARP-I	WASID	1954-65	64	14	6	14	2
	Master Planning	1977-78	86	4	5	3	2
	S.M.O.	1981-82	77	15	5	3	-
SCARP-II	WASID	1954-65	62	25	5	5	3
	Master Planning	1977-80	83	7	4	3	3
	S.M.O.	1983-85	85.4	8.9	2.7	1.0	2
SCARP-III	WASID	1954-65	55	26	8	10	1
	Master Planning	1977-78	74	4	16	4	2
	S.M.O.	1982-83	72	16	6	5	1
SCARP-IV	WASID	1954-65	40	35	9	15	1
	Master Planning	1976-80	63	15	12	8	2
	S.M.O.	1986-87	73	10	10	4	3
<u>N.W.F.P.</u>							
Peshawar SCARPs	C.M.O.	1971-75	67	7	3	5	18
	Master Planning	1977-78	75	4	3	1	17
<u>SIND</u>							
Khairpur SCARP		1953-54	24	45	25	3	3
	Master Planning	1977-78	70	19	5	1	5
North Rohri		1953-54	46	26	13	14	1
	Master Planning	1978-79	76	14	5	4	1

Source: SCARPS Monitoring Organization, WAPDA, Lahore.

TABLE - 10  
PROFILE SALINITY IN SCARPS

SCARPS	Agency	Period	Profile salinity classes percent				Missing
			NS-NS	NS - S	S - S	S-NS	
<u>PUNJAB</u>							
SCARP-I	WASID	1962-63	34	13	41	5	7
	Master Planning	1977	70	9	17	2	2
	S.M.O.	1981-82	60	11	26	2	1
SCARP-II	WASID	1962-65	58	9	25	8	-
	Master Planning	1977-80	78	8	10	4	-
	S.M.O.	1983-85	79	7	13	1	-
SCARP-III	WASID	1962-65	49	6	38	7	-
	Master Planning	1977-78	69	6	16	6	3
	S.M.O.	1982-83	64	8	24	4	-
SCARP-IV	WASID	1962-65	25	28	46	1	-
	Master Planning	1977-78	62	16	20	1	1.3
	S.M.O.	1986-87	64	13	22	0.5	0.3
<u>N.W.F.P.</u>							
Peshawar SCARP	Master Planning	1978-79	92	2	2	4	-
<u>SIND</u>							
Khairpur SCARP	Master Planning	1977-78	50	4	30	14	2
North Rohri	Master Planning	1978-79	55	2	24	19	-

Source: SCARPS Monitoring Organization, MAPDA, Lahore.

**TABLE - 11**  
**GROUND WATER QUALITY OF SCARPS**

Name of Scarp	Total No. of T/w.s. installed	Year of sampling	No. of T/w.s. tested	Water Quality					
				Usable		Marginal		Hazardous	
				No.	%	No.	%	No.	%
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
<b>PUNJAB:</b>									
I.	2074	1962-63	1720	655	38	601	40	384	22
		1967-68	1484	463	31	580	39	441	30
		1972-73	1875	791	42	669	36	415	22
		1976-77	1720	636	37	706	41	378	22
		1980-81	1793	596	33	798	45	399	22
		1984-85	1687	633	37	650	39	404	24
		1988-89	1438	431	30	632	44	376	26
II.	2205	1975-76	1658	1030	62	456	28	172	10
		1978-79	1915	1185	62	515	27	215	11
		1979-81	631	36	53	94	15	201	32
		1982-83	1392	981	70	346	25	65	5
		1983-84	1683	1123	67	437	26	123	7
		1986-88	1762	1030	59	515	29	210	12
III.	1635	1969-74	1527	1208	79	230	15	89	6
		1977-78	1527	1158	76	246	16	123	8
		1981-82	1210	693	74	217	18	100	8
		1982-83	1424	1017	71	285	20	121	9
		1985-86	1270	883	69	263	21	124	10
IV.	940	1970-74	882	712	81	154	17	16	2
		1976-77	882	569	64	306	35	7	1
		1979-80	757	532	70	222	29	3	1
		1983-85	885	611	71	234	28	5	1

Source: SCARFS Monitoring Organization, SAFDA, Lahore.

Cont'd...

## GROUND WATER QUALITY OF SCARPS

Name of Scarp	Total No. of T/w.s. installed	Year of sampling	No. of T/w.s. tested	Water Quality					
				Unble		Marginal		Hazardous	
				No.	%	No.	%	No.	%

N.W.F.P.

Peshawar	155	1975-76	54	42	78	11	20	1	2
		1976-77	62	57	92	5	8	0	0
		1977-78	83	77	93	6	7	0	0
		1978-79	119	107	90	12	10	0	0
		1979-80	131	121	92	10	8	0	0
		1981-82	131	119	91	12	9	0	0
		1982-83	146	134	92	12	8	0	0
		1983-84	145	133	92	12	8	0	0
		1984-85	141	126	89	15	11	0	0
		1985-86	156	142	91	14	9	0	0
		1986-87	82	77	94	5	6	0	0
1987-88	130	120	93	9	6	1	1		

Cont'd...

## GROUND WATER QUALITY OF SCARPS

Name of Scarp	Total No. of T/ws. installed	Year of sampling	No. of T/ws. tested.	Water Quality					
				Usable		Marginal		Hazardous	
				No.	%	No.	%	No.	%
<u>Sind</u> Khairpur	540	1965-67	478	277	58	64	13	136	29
		1976-77	93	77	83	15	16	1	1
		1979-80	146	101	69	42	29	3	2
		1980-81	147	105	71	39	27	3	2
		1982-83	288	146	52	71	24	71	24
		1983-84	224	69	31	33	15	122	54
		1985-86	435	194	45	82	19	159	36
		1986-87	301	81	27	65	22	155	51
1987-88	240	130	54	45	19	65	27		

Cont'd...

## GROUND WATER QUALITY OF SCARPS

Name of Scarp	Total No. of T/ws. Installed	Year of sampling	No. of T/ws. tested.	Water Quality					
				Usable		Marginal		Hazardous	
				No.	%	No.	%	No.	%
North	1192	1975-76	63	37	59	21	33	5	0
Rohri		1977-78	662	513	77	111	17	38	6
		1980-81	576	431	75	114	20	31	5
		1981-82	692	539	78	126	18	27	4
		1982-83	726	564	78	132	18	30	4
		1983-84	781	624	80	137	17	20	3
		1985-86	831	676	73	195	21	60	6
		1986-87	592	444	75	126	21	22	4
		1987-88	665	469	71	149	22	47	7

TABLE - 12  
SCARP-WISE CROPPED AREA

Years	-000- hectares metre						
	SCARP-I	SCARP-II	SCARP-III	SCARP-IV	SCARP Peshawar	SCARP Khairpur	Scarp North Rohri
1959-60	370.45						
1960-61	395.10						
1961-62	417.36						
1962-63	456.32						
1963-64	483.61						
1964-65	499.46						
1965-66	546.47						
1966-67	502.37					137.77	
1967-68	496.62					170.85	
1968-69	527.57		308.22	139.49		173.19	
1969-70	509.53		312.85	148.47		169.27	
1970-71	513.44		314.00	161.00		157.47	
1971-72	515.66		315.19	174.00		165.75	
1972-73	497.90	569.61	337.67	183.91		170.33	246.04
1973-74	532.40	648.72	366.35	191.10		170.81	242.92
1974-75	529.65	648.35	362.89	195.54	58.97	178.79	261.91
1975-76	538.59	661.00	374.89	199.70	58.86	187.27	274.29
1976-77	547.36	671.89	383.42	202.22	60.33	186.65	280.93
1977-78	559.22	691.49	382.67	207.67	61.46	192.13	292.66
1978-79	574.36	691.22	411.33	218.59	65.33	201.81	302.79
1979-80	574.99	710.31	416.38	223.85	67.17	209.48	318.34
1980-81	565.81	713.17	435.74	224.28	69.85	211.16	315.15
1981-82	564.17	729.96	449.33	223.33	69.57	211.75	319.57
1982-83	559.79	727.15	467.73	230.48	71.30	211.65	279.68
1983-84	557.02	713.49	467.36	229.95	71.36	181.40	310.51
1984-85	543.48	730.57	466.57	226.53	71.57	182.67	328.37
1985-86	545.32	742.35	469.34	234.17	72.55	182.55	298.17
1986-87	539.47	735.62	497.55	243.31	72.40	180.47	307.55
1987-88	531.93	730.24	478.03	230.30	73.10	184.18	304.11

Source: SCARPS Monitoring Organization, WAPDA, Lahore.