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EVALUATION OF O&M MECHANIZATION PROGRAM IN THE PROVINCIAL IRRIGATION DEPARTMENTS

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Evaluation of O&M Mechanization in the Provincial Irrigation Departments

SUMMARY

The Indus Irrigation System in Pakistan is the largest integrated irrigation system in the world, serving a culturable area of about 14 million hectares. The total length of canals is about 60,000 kilometers. Most of the canals have earthen banks, with normal water surface level above grade and are vulnerable to rapid deterioration if not maintained properly. Extensive deterioration has occurred due to deferred or improper maintenance. Many of the canals are operating with inadequate or the bare minimum of free board, eroded berms, narrow operating roads, and deteriorated outside embankments. The purpose of the O&M mechanization program is to test if deterioration of the canal banks can be arrested by introduction of mechanization.

Under current methods, manual labor is used to perform routine maintenance and minor repairs of canal banks. More substantial repairs are usually performed by local contractors using manual and animal labor and light mechanized equipment. The mechanized equipment in the possession of the Provincial Irrigation Departments (PIDs) is used primarily for major rehabilitation and repair of the canal system and is too large for routine maintenance of canal banks. Also, the equipment with the PIDs is in specialized mechanical units and is not readily available to the canal operating units for routine maintenance and emergency repairs.

Provision of light mechanized equipment for direct use by the units responsible for canal O&M was proposed in the USAID ISM-II Project as an approach to achieving a satisfactory level of maintenance. It was envisaged that by mechanization, the PIDs would be able to enhance their capabilities, increase performance, improve management control, and use their existing labor and financial resources more effectively.

A pilot program was carried out in nine irrigation divisions around the country to test the mechanization concept. The program was monitored for one year to evaluate its effectiveness for maintenance and repairs, comparative cost, and institutional acceptability. The overall conclusion of the evaluation is that organized and efficient use of mechanized equipment by the operating divisions would increase the standard of maintenance of canal banks in a highly cost effective manner.

THE TRIAL

The purpose of the one-year trial was to test the concept of improving canal bank maintenance through use of light mechanized equipment. The trial program started with the Punjab province in September 1991 and was officially ended with a final evaluation workshop on 18 February 1993. The trial evaluated the performance of the equipment, the level of equipment utilization, cost of performing works, acceptability to the users, institutional requirements and constraints, and the impact after one year on the condition of canals in the trial divisions.

The Equipment Package

The composition of the equipment package was selected jointly by the ISM-II Project Team and representatives of the PIDs. The criteria for selection included moderate cost, simplicity of operation, indigenous manufacture, widespread availability of spare parts and repairs, and ease of operation and maintenance.

Two types of equipment packages were provided. The standard package, called the SDO's package supplied to each trial sub-division contains the following equipment:

50 HP Massey Ferguson tractor	1
Front end dozer blade	1
Rear end grader blade	1
Tipping trolley	1
Water sprinkler trailer	1

In addition, each subdivision was provided with a Suzuki jeep and a pickup truck to be used in conjunction with the package.

A special package, intended to supplement the SDOs' packages on an as-needed or rotational basis, was supplied to each divisional headquarters and was called the XEN's package. This package included with the same tractor, a chisel plough, a front end loader, and a Suzuki jeep. XENs were also supplied with a flat bed truck for transportation of machinery. Motorcycles were also provided for the subengineers in one division in each province.

Monitoring Program

A monitoring program was conducted in all provinces to provide a basis for evaluation of the trial. The program was coordinated by the Technical Assistance Team, with the involvement of the executing officers of the trial divisions, high level PID officials, and officials of USAID. Close liaison was kept with the trial divisions throughout the one-year monitoring period. TA team

members made field visits to collect monitoring information on standard forms and progressively analyzed data as it was received.

A discussion workshop was held about midway through the trial period involving SDOs, XENs, SEs, Chief Engineers and Provincial Coordinators. The purpose of the workshop was to discuss problems being experienced by the executing officers, SDOs and XENs, and to bring them to the attention of higher officials. Based on this experience, recommendations were obtained from the executing officers for modifications and improvements, especially to the equipment package. A workshop report was prepared.

Near the end of the trial, a questionnaire was used as a basis for field interviews by the TA team of all available XENs, SDOs, and sub-engineers. The purpose of the questionnaire was to systematically record the opinions and conclusions of the executing officers regarding the suitability of the equipment, its effectiveness, and the viability of the mechanization concept.

After the completion of the field monitoring program and analysis of field data, a final discussion workshop was held in Lahore on 18 February 1993. In this workshop, the results of data analysis and the questionnaire interviews were presented to management and policy level representatives of the four PIDs. They were requested to express the desires of the departments as to adoption of light mechanization of civil divisions and to give assurances that institutional procedures for efficient utilization of the equipment would be regularized.

ANALYSIS

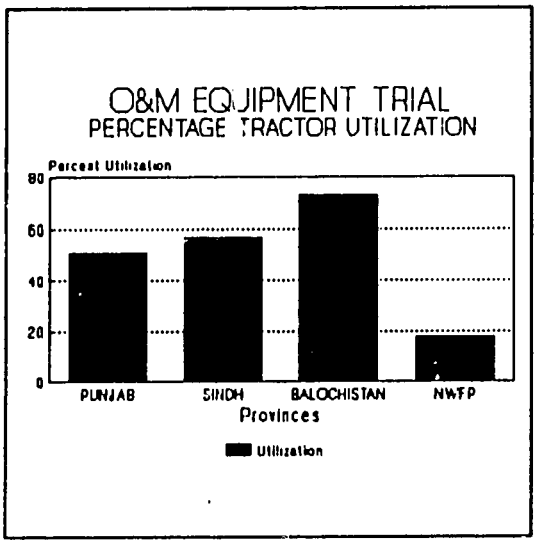
Equipment Utilization

A level of 100 hours per month was set as the desired target level for tractor utilization. The overall utilization during the trial period was 53 percent of the target, varying among divisions from a low of 18 percent to a high of 73 percent. This overall utilization was for both XENs' and SDOs' packages. The average utilization just for the SDOs' package was 65 percent of the target. The utilization levels by province, for both XENs' and SDOs' packages, are shown in the bar chart.

The primary reason for less than target level utilization was unavailability of operating funds to the officials responsible for operating the equipment in some cases, and due to administrative problems in others, as detailed in the main report.

After release of funds for the 1993 fiscal year, the level of utilization in Punjab showed a significant increase. Utilization

was also affected by the exceptional rains and flooding in summer 1992, especially in Sindh. However, the equipment was found to be very useful in flood fighting and restoration activities. The special equipment package with the XENs was not fully utilized, primarily due to inadequate work planning and coordination.

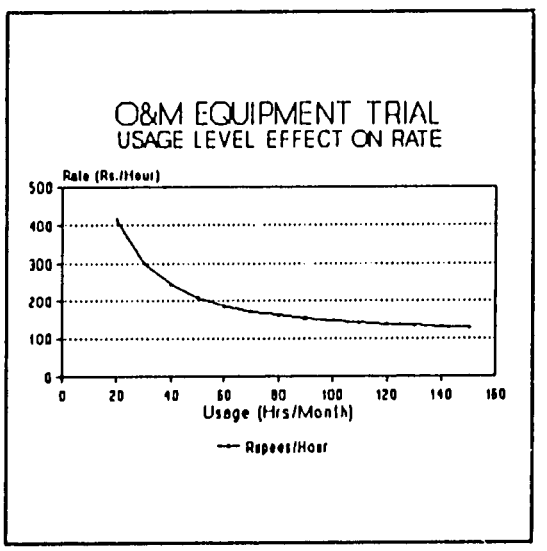


The utilization of tractor drawn implements varied with the type of work done. In Balochistan, where most work was routine maintenance of canal bank roadways, the grader blade and the sprinkler trailer were the most used implements. In Punjab and Sindh, emphasis was on canal bank repair, resulting in highest use of the dozer blade and grader blade. In NWFP, maximum use was made of the tipping trolley for transportation of earth and gravel. The chisel plow and front-end loader had low utilization primarily because they were with the XENs' packages.

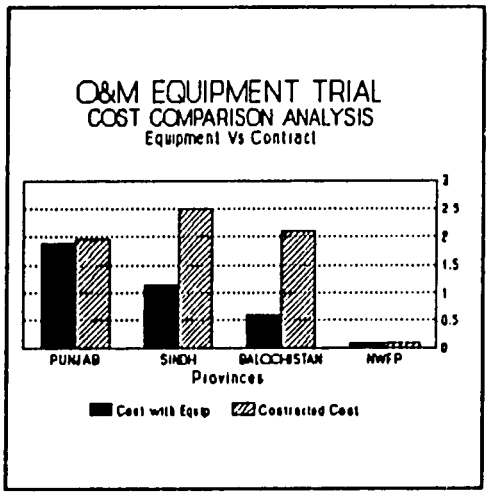
The light vehicles that were provided, Suzuki jeeps and pickup trucks, were useful to the SDOs and XENs but had essentially no use directly related to the tractor equipment. The tractors themselves were the primary means of transportation for personnel and materials involved in their work. The flat bed trucks provided to the XENs were hardly used. Motorcycles provided to sub-engineers were considered desirable in all provinces except NWFP.

Cost Effectiveness

A cost of Rs 150 per hour for the equipment package was calculated as the sum of the direct operating cost and the amortization of the capital cost. The direct operating cost of Rs 71 per hour is the cost of fuel and lubricants, operator salary, and maintenance and repairs. The amortization cost, or capital recovery, is based on the manufacturer's recommended life of the equipment, in years or hours, whichever is less, and 10 percent interest. Since amortization is essentially a fixed cost per year, the cost per hour decreases as utilization increases. Although overall utilization was only 53 percent, the Rs 150 per hour cost used in the analysis is based on 100 hours per month on the



rationale that in a fully implemented and regularized mechanization program, 100 hours per month utilization should be readily achievable. The variation of hourly cost with utilization is shown on the graph.



The cost of using the equipment package was compared with the cost of performing the same work by contractors under the Schedule of Rates prevailing in each province. The overall ratio of cost of performing the same work by contractors as compared to the equipment package was 1.67. Even at the 53 percent utilization rate actually achieved in the trial, the ratio would be about 1.34. The ratios are only indicative since they are based on many assumptions, including the life of equipment, the interest rate, and the cost of equipment maintenance. The cost comparison also varies with the quantities of various types of work done. At current Schedules of Rates, the cost of the equipment package is most favorable for grading and least favorable for sprinkling.

Assessment by Users and TA Team

Near the end of the trial period the participating XENs, SDOs, and subengineers were interviewed using a standard questionnaire. The following is a summary compilation of the results of the questionnaire survey and of other monitoring activities of the TA Team.

a) The equipment, in general, proved to be effective. In response to the questionnaire, 100 percent of users in Punjab, Sindh, and Balochistan described the equipment as an effective tool.

b) The equipment has proved to be useful for emergency repairs to canal systems, particularly because of its immediate availability.

c) All subdivisions in the trial program reported that their M&R (maintenance and repair) capability has improved after provision of the mechanized equipment.

d) The divisions in the trial recommended that similar equipment should be provided to all divisions of the irrigation departments.

e) Shortages of funds with the executing subdivisions for operation of O&M equipment was one of the main constraints on utilization of the equipment.

f) Use of O&M equipment has not as yet been adopted as a part of routine departmental activity. Specific directives are required from top management to institutionalize the program.

g) Low utilization was also the result of lack of supervisory follow up over the executing subdivisions.

h) Official procedures for documentation of expense accounts for use of O&M trial equipment did not exist. This contributed to low utilization of equipment in many subdivisions.

i) There was a lack of coordination between XENs and SDOs, resulting in low utilization of the XENs' package, which was intended to be used as-needed by the respective SDOs.

In summary, there is almost universal agreement that the equipment package is effective and economical for performing routine maintenance and emergency repairs of canal banks. Some minor modifications are desirable. Utilization during the trial period was low primarily because the slow pace of institutionalization. It can be reasonably be expected that light mechanized equipment would be efficiently utilized if standard procedures are established for administration, budgeting, and accounting for expenditures relating to equipment use.

EVALUATION AND RECOMMENDATIONS

The trial clearly demonstrated that the equipment is effective for routine maintenance and for repairs. It is especially useful for the emergency repairs of canal breaches and flood damages. It is economical in comparison to traditional methods, providing a reasonable level of utilization is achieved. Divisions participating in the trial were judged to have achieved a better state of maintenance than other divisions in the same circles. Most of the problems were institutional or budgetary but high level PID officials assured that these can be resolved.

Evaluations and recommendations in terms of specific issues are given below. These evaluations and recommendations represent the consensus of the Technical Assistance Team, executing officers participating in the program, and senior representatives of the Provincial Irrigation Departments.

Equipment Package

There is almost universal agreement that the equipment package provided to the subdivisions is effective for performing routine maintenance and emergency repairs of canal banks. However, some minor modifications are desirable.

It is recommended that the equipment package should only be provided for subdivisions. The SDO package should be modified by deleting the Suzuki jeep and pickup truck and by adding a chisel plough.

The recommended package which should be supplied to each subdivision is as follows:

a)	50 HP tractor	1
b)	Front end dozer blade	1
c)	Rear end grader blade	1
d)	Chisel plough	1
e)	Tipping trolley	1
f)	Water sprinkler trailer	1

It is also recommended that motorcycles be provided to each subengineer. However, the cost of motorcycles and their operation was not included in the cost analysis because they did not actually contribute to the work done by the tractor package. The other vehicles, Suzuki jeep, pickup truck, and flat-bed truck did not prove to be essential to the package. A wheel-mounted scraper was not delivered in time for it to be evaluated fully, but should be considered in a mechanization program.

Financial Viability

The comparative cost of doing work with the light mechanized equipment and by contract indicated an approximate comparative cost ratio of about 1.67 between the Schedule of Rates and the tractor package, assuming that the equipment would be utilized at about 100 hours per month. Even at lower utilization rates, mechanization is financially attractive. The cost rate used for the mechanized equipment includes provision for equipment replacement providing for a self sustaining program.

Our analyses also show that a full-scale mechanization will not put additional burden on PIDs M&R budget, if the current level of allocation is maintained.

Equipment Utilization

Although the average tractor utilization for the four provinces was 53 percent, the low rate was primarily due to administrative factors. The senior representatives of the PIDs assured that these administrative constraints would be removed in case of a full-scale mechanization program.

State of Maintenance

It was observed and confirmed by the SEs participating in the final workshop that in their circles the condition of channels, canal banks, and roads were comparatively better in the division with the mechanized equipment than in the divisions without these equipment.

Establishment of Funds

The results of the trial and the consensus reached at the final evaluation workshop clearly demonstrated that the funding problem, which included allocation and release of funds for the equipment operation, was the single major issue affecting equipment use and utilization in every sub-division in the trial program.

At the start of the trial, the understanding with the high officials of PIDs was that the current M&R funds would be used at the discretion of the SDOs and XENs for operating the equipment. The analysis showed that executing officers either received conflicting directives or were uncertain that use of M&R funds was allowable for the equipment operation at their discretion. The analysis has also shown that the current sub-divisional budgets are adequate and do not require upward revisions for use of O&M equipment by the subdivisions.

Mechanized Equipment in Civil Divisions

Although traditionally, all machinery and heavy equipment comes under mechanical units, it is the consensus that light mechanized equipment under the control of civil divisions is desirable for many reasons. These include: easy accessibility, decrease in response time during emergencies, minimizing time required for closing canal breaches, and elimination of the administrative burden and higher cost of outside contracting for routine and emergency works. The control of O&M equipment would make civil divisions self-sufficient and independent. It would also ensure an efficient use of machinery in conjunction with or in addition to the existing resources, such as manual labor.

Full-Scale Mechanization

Regularization or institutionalization of a full-scale mechanization program would require efforts on behalf of irrigation officers at all levels. Foremost is a directive at the highest level (the Secretary) of the Irrigation Departments that the Department is committed to an O&M mechanization program and execution of this directive by the Chief Engineers.

The establishment of a regular funding procedure is imperative before the execution phase begins. In this connection, not only the allocation of funds is necessary but the release of these funds for maintenance operations needs to be streamlined. A reporting mechanism should be established to monitor equipment operations.

Management and Policy Level Decisions

The consensus at the final workshop was that there are no major policy level decisions needed to be made for initiating the mechanization program. As stated earlier, a high level directive (from the Secretary) and execution of this directive by the Chief Engineers would give incentives to the executing officers at the divisional level.

Expansion of Mechanization

Based on the consensus reached at the final evaluation workshop, responses on the questionnaire distributed to the trial subdivisions and results of one-year trial program, it is recommended that the mechanization of routine maintenance should be expanded to all irrigation divisions having conventional earthen canals. This expansion should consider the recommendations made on equipment package mix, financial viability, funds required, desired utilization levels, and institutional adjustments.

Assurances to Potential Donors

The O&M Equipment Trial Program has demonstrated that the PIDs are desirous of mechanization of routine maintenance and are prepared to make the commitments necessary to obtaining full benefits of mechanization. Factors such as low tractor utilization in NWFP, under utilization of XEN's package and shortage of funds in certain sub-divisions should not be considered as a failure of the equipment trial. Rather, these observations provide information and guidance for establishment of an effective mechanization program.

The representatives at the final evaluation workshop stated that the PIDs would agree to provide assurances to donors, in committing funds, ensuring release of funds, hiring qualified operators, establishing monitoring procedures, and full-scale regularization of the program.

Evaluation of O&M Mechanization in the Provincial Irrigation Departments

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I. INTRODUCTION

The Indus Irrigation System in Pakistan is the largest integrated irrigation system in the world, serving a culturable area of about 14 million hectares. The total length of canals is about 60,000 kilometers. Most of the canals have earthen banks, with normal water surface level above natural ground surface and are vulnerable to rapid deterioration if not maintained properly. Extensive deterioration has occurred due to deferred or improper maintenance. Many of the canals are operating with inadequate or no freeboard, eroded berms, narrow operating roads, and deteriorated outside embankments. The purpose of the O&M mechanization program is to test if deterioration of the canal system can be arrested by introduction of mechanization.

Under current methods, manual labor is used to perform routine maintenance and minor repairs of canal banks. More substantial repairs are usually performed by local contractors using manual and animal labor and light mechanized equipment. The mechanized equipment in the possession of the Provincial Irrigation Departments (PIDs) is used primarily for major rehabilitation and repair and is too large for routine maintenance. Also, the equipment with the PIDs is in specialized mechanical units and is not readily available to the canal operating units for routine maintenance and emergency repairs.

Provision of light mechanized equipment for direct use by the units responsible for canal O&M was proposed in the USAID ISM-II Project as an approach to achieving a satisfactory level of maintenance. It was envisaged that by mechanization, the PIDs would be able to enhance their maintenance capabilities, increase performance, improve management control, and use their existing manpower resources more effectively.

A pilot program was carried out in nine irrigation divisions around the country to test the mechanization concept. The program was monitored for one year to evaluate its effectiveness for maintenance and repairs, comparative cost and institutional acceptability. The overall conclusion of the evaluation is that organized and efficient use of mechanized equipment by the operating divisions would increase the standard of maintenance of canal banks in a highly cost effective manner.

II. BACKGROUND

One objective of the Irrigation Systems Management Project - Phase II (ISM-II) is to develop the capacity for sustained and proper operation, maintenance, and management of the rehabilitated irrigation systems. The light mechanization of routine maintenance is one of the components of ISM-II.

The World Bank Staff Appraisal Report (SAR) and the USAID Project Paper both state that, on a pilot basis, the ISM-II Project would provide light mechanized O&M equipment (50HP farm tractors with blades, trolleys, water tanks, compactors, pick-up trucks etc.) to selected divisions and subdivisions to determine its utility and effectiveness.

It was also stated that the equipment supplied shall be carefully monitored by the PIDs and the Technical Assistance Team to assess its suitability and cost-effectiveness for routine maintenance of the channels. Based on satisfactory experience, the program would be expanded to other divisions.

The Harza/DAI/ACE Technical Assistance team undertook this task and held a meeting of the Provincial Advisors on the subject of O&M Planning on 26 September 1990. The purpose of this meeting was to share experiences on O&M activities of the Project and develop future strategies. One of the topics under discussion was O&M Equipment Trial Program. A consensus was reached that a planning workshop should be held with PID officials belonging to the selected sub-divisions. This workshop would give an awareness to the participants on the trial program and would help in answering questions regarding the program. Issues such as PID's commitment to the trial program, availability of operators, POL expenditures, and repair and maintenance of the trial equipment were to be discussed.

On 3 December 1990 an O&M Planning Workshop was held in Rawalpindi and was attended by executive engineers, superintending engineers and chief engineers along with representatives of USAID and the TA Team. Among the objectives of this workshop were to develop concepts for implementing, monitoring, and evaluating the O&M Equipment Trial Program. The consensus reached at this workshop is given in Annex I.

The trial program started with the Punjab Province in September 1991 and was officially concluded, with the final evaluation workshop, on 18 February 1993. In the next chapters of this report, a description of the O&M Trial Program, monitoring activities, data collection and analyses, outcomes, evaluations, and recommendations are presented.

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III. THE TRIAL

A trial program was carried out in nine irrigation divisions around the country to test the mechanization concept. The program was monitored for one year to evaluate its effectiveness for maintenance and repairs, comparative cost, and institutional acceptability.

The Concept

The philosophy behind the entire exercise was to test the concept of improving canal bank maintenance through use of light mechanized equipment. The trial was to evaluate the performance of the equipment, the level of equipment utilization, cost of performing works, acceptability to the users, institutional requirements and constraints, and the impact after one year on the condition of canals in the trial divisions.

Selection Criteria

The equipment was selected and packages were formulated after meetings and agreements reached with the representatives of the four Provincial Irrigation Departments. The criteria for selection included moderate cost, simplicity of operation, indigenous manufacture, widespread availability of spare parts and repairs, and ease of operation and maintenance.

Two types of equipment packages were formulated. The standard equipment package (called SDO's package) was placed under the control of civil subdivisions responsible for canal maintenance. The second package (called XEN's package) was placed at the canal divisional level for use by respective subdivisions, on an as-needed or rotational basis.

The Packages

The standard O&M equipment package at the subdivisional level consisted of the following equipment:

50 HP Massey Ferguson tractor	1
Front end dozer blade	1
Rear end grader blade	1
Tipping trolley	1
Water sprinkler trailer	1

In addition, a Suzuki jeep and a pickup truck were provided to each subdivision to be used in conjunction with the package. Later in the trial motorcycles were also provided for the subengineers in one division of each province. It was originally intended that vibratory compactors, which were already provided to the PIDs by

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USAID, would become part of the package in each subdivision. However, the physical transfer of compactors to the trial subdivisions was not accomplished during the program.

The XEN's package, which was intended to supplement the SDO's package on as-needed basis, was supplied with the same tractor, a chisel plough, a front end loader, and a Suzuki jeep. XENs were also supplied with a flat bed truck for rapid shifting of machinery from one point to another. The technical specifications of the equipment are given in Annexure II.

The equipment packages were expected to enhance the routine maintenance of canal banks, such as regular watering and minor earth work repairs. The pickup truck, Suzuki jeep, trolley and flat bed truck as well as for carriage of material and equipment were intended to improve the mobility of staff.

Site Selection

After detailed deliberations with the Provincial Irrigation Departments, the following divisions and their component sub-divisions were selected for participation in the trial:

Punjab

1. Lahore Canal Division along with its Lahore, Pandoki and Bhamba (Chaga Manga) Subdivisions.
2. Kirana Canal Division along with its Kirana, Khadir, Laluwali and Hujjan Subdivisions.
3. Multan Canal Division along with its Multan, Rashida and Sidhnai Subdivisions.
4. Bahawalpur Canal Division along with its Baghdadul Jadid, Qaimpura and Shahiwala Subdivisions.

Sindh

1. Fuleli Canal Division along with its Matli, Badin and Tando Bago Subdivisions.
2. Hala Canal Division along with its Hala, Shahdadpur and Tando Adam Subdivisions.
3. Jamrao Canal Division along with its Mirpurkhas, Johl and Khadro Subdivisions.

NWFP

1. Southern Circle Bannu with its Marwat Canal Division (in Headworks Subdivision), Bannu Canal Division (in Sarae Naurang Subdivision) and Paharpur Canal Division (in Marginal Bund Subdivision).

The original distribution in NWFP was in a division with

subdivisions having gravel bearing canal banks, so it was decided by PID to change the distribution to earthen canal subdivisions selected as above. The equipment transfer delayed the start of the trial in NWFP.

Balochistan

1. Pat Feeder Canal Division with its Dera Murad Jamali, Goth Tagia, Hair Din, and Jat Pat Subdivisions.

Pre-Trial

The first set of one tractor and its implements were delivered in the Pandoki Subdivision of Lahore Division on 10 July 1991. This equipment set was used for a pre-trial by the TA team and the subdivisional staff to determine if there were any deficiencies in the equipment, to develop equipment working procedures, and to formulate and test a training program for staff and operators.

A training program was conducted by the staff of the Millat Tractor at site on 15 July 1991. The TA team supervised the training program.

As a result of this pre-trial, some immediate modifications in the equipment were suggested and were incorporated by the manufacturers. The modified version of the equipment was then supplied to all the remaining divisions and subdivisions.

Training Program

After the initial training program at Pandoki Sub-division, a full-scale training program was launched at the other participating divisions and subdivisions. Before the start of training in each province, a one day seminar was held in each province to acquaint Chief Engineers, SEs, and XENs of the participating units with the objectives of the trial program. In these seminars, commitments were also made for availability of staff, operators, and POL at the time of training. See Annex III for details on the seminars.

Soon after the seminar in each province, training started and was completed successfully. As stated earlier, the training was conducted by the Millat Tractor staff and supervised by the TA team members.

The training plan that was used in all the four provinces was designed, tested and modified during the pre-trial and is included in Annexure III. An overview of a typical training program, conducted at Dera Murad Jamali, is also summarized in Annexure III.

Delivery of Equipment

Before the start of the training program, an aggressive delivery schedule of the tractors and implements was developed.

Millat Tractor and JECO, in close liaison with the TA team, were successful in delivering the equipment to the participating divisions and subdivisions before the scheduled training dates.

The program start-up events that took place are summarized in Table A below.

TABLE A

TRAINING AND DELIVERY SCHEDULE

Division	Seminar Date	TA Team Visit	Delivery Date	Training Date
Punjab: Lahore	Aug 3 '91	Aug 3 '91	Jul 9 '91	Jul 14-31 1991
Kirana		Aug 16 '91	Aug 14 '91	Aug 25-29 1991
Multan		Aug 18 '91	Aug 15 '91	Sep 1-5 1991
Bahawalpur		Aug 20 '91	Sep 2 '91	Sep 8-12 1991
Sindh: Fuleli	Sep 25 '91	Oct 8 '91	Oct 2 '91	Oct 13-17 1991
Hala		Oct 10 '91	Oct 12 '91	Oct 20-24 1991
Jamrao		Oct 9 '91	Oct 15 '91	Oct 27-31 1991
NWFP: Marwat Canal	Nov 18 '91	Nov 20 '91	Oct 17 '91	Nov 23-27 1991
Balochistan: Pat Feeder	Dec 9 '91	Dec 10 '91	Dec 5 '91	Dec 12-18 1991

Throughout this period the staff of Millat Tractor and JECO Engineering remained active and cooperative. Their efforts in making timely delivery and coordinating training dates on schedule were commendable.

The vehicles were delivered by USAID directly to the trial

divisions. The Suzuki jeeps and pickup trucks were delivered much before the start date of the trial due to the USAID procurement schedule. Initially, there were some problems with delivery at wrong locations but these were sorted out with the PIDs. The flat-bed trucks were delivered very late in the trial program, March 1992, due to the USAID requirement for US procurement. However, similar trucks are manufactured in Pakistan.

Monitoring of the Trial

A monitoring program was conducted in all provinces to provide a basis for evaluation of the trial. The program was coordinated by the Technical Assistance Team, with the involvement of the executing officers of the trial divisions, high level PID officials, and officials of USAID. Close liaison was kept with the trial divisions throughout the one year monitoring period.

TA team members made field visits to collect monitoring information on standard forms and progressively analyzed data as it was received. A questionnaire was designed to record opinions and conclusions of the executing officers.

Mid-Term Evaluation Workshop

A mid-term evaluation workshop was held in Lahore on 2-3 March 1992 involving SDOs, XENs, SEs, Chief Engineers and Provincial Coordinators. A strategy in workshop design was to limit participation on the first day to SDOs and XENs to allow them freedom of discussion of their problems in the absence of higher authorities. On the second day, the SDOs did not participate and XENs were available to convey the problems and recommendations to the SEs, Chief Engineers, and Provincial Coordinators.

The purpose of the workshop was to discuss problems being experienced by the executing officers, SDOs and XENs, and to bring them to the attention of higher officials. Based on that experience, recommendations were obtained from the executing officers for modifications and improvements, especially to the equipment package.

Some of the objectives that were accomplished in the workshop were: exchanging of current information, sharing experience of the trial to date, soliciting opinions of the users on the equipment suitability, identifying implementation problems, and proposing solutions and gaining support from the high level irrigation officials.

A detailed description of the workshop and its outcomes is summarized in Annexure I.

Final Evaluation Workshop

To reach a consensus on the final results of the monitoring program, a final evaluation workshop was held in Lahore on 18 February 1993. Senior representatives of the four Provincial Irrigation Departments attended.

The purpose of the workshop was to obtain the contribution of senior officials and policy makers to the final evaluation of the O&M Equipment Trial.

The questions that were put to the groups for discussion included:

- Is the use of mechanized equipment by civil divisions desirable from the management and policy level? What are the pros and cons?

- Are you aware of any improvement in level of maintenance in divisions with the equipment as compared to those divisions without such equipment?

- Should the mechanization program be expanded to other divisions? How can assurances of adoption and utilization be given to donors?

- What must be done to regularize a full-scale mechanization program?

- What procedures should be established to ensure funds for equipment operation?

A summary of the consensus and agreements reached in this workshop is included in Annex I.

IV. THE ANALYSIS

Data Collection Methodology

During the monitoring program, information was collected through two major means, proforma and questionnaire.

The three proformas that were used are as follows:

- Form A for basic tractor usage data. This proforma records the daily use of tractor, including work and POL details (See Annex IV).

- Form B for details of implements used with the tractor and details of work performed with the equipment. It also records Non-Productive Hours (NPU) of use, described as the time the tractor was running but not doing work (See Annex IV).

- Form C to determine the pre- and post-trial condition of the canal/drain section, where equipment was used (See Annex IV).

The data collected through these forms were analyzed to provide information on effectiveness and suitability of the equipment, cost comparisons with traditional procedures, and evaluation of the acceptance of the concept and potential for institutionalization.

Although SDOs and XENs of the trial divisions were requested to submit the completed forms, it was found to be more practical for members of the Technical Assistance Team to visit the field sites and assist in filling in the forms. Although the purpose of providing the equipment is to improve the status of maintenance of the canals, it was found not practicable to make this assessment on a proforma basis. The TA team also kept close liaison with the trial divisions to assist the participants in resolving problems.

Near the end of the trial, a questionnaire (See Annex IV) was used as a basis for field interviews of all available XENs, SDOs and subengineers. The purpose of this questionnaire was to systematically record the opinions and conclusions of the executing officers regarding suitability of the equipment, its effectiveness, and viability of the mechanization concept. The results of the questionnaire were analyzed by the TA team.

Analysis

Based upon the data collected and opinions recorded, the analyses were made of the following:

a) Tractor utilization
b) Implement utilization
c) Financial analysis, and
d) Users opinions

Tractor Utilization

Monthly data for each SDOs'and XEN's tractor was collected using Form A. This data is summarized, by provinces, in Table B below which contains combined utilization of SDOs' and XENs' packages in column 4 and utilization just for SDOs' package in column 5.

Percentage utilization is calculated based on a target of 100 hours per month per tractor. This is a fairly modest target, as the normal work month exceeds 150 hours.

TABLE B

PROVINCE WISE UTILIZATION ANALYSIS

Province	Months Used	Total Hours Used	Percent Utilization* (Both Packages)	Percent Utilization* (SDOs Package only)
Punjab (17 Pkgs)	16	12613	51	65
Sindh (12 Pkgs)	13	9420	57	70
Baloch (5 Pkgs)	12	4066	73	80
NWFP (4 Pkgs)	9	649	18	24

* Per tractor/month

The level of utilization by provinces ranges from 18 percent to 73 percent. In the case of NWFP, start of equipment use was delayed by transferring the equipment to different locations after delivery, see Table C below.

Equipment utilization was affected by various factors. In Punjab, utilization was said to be limited because of department-wise shortage of funds until release of the 1993 budget in September 1992, when an increase in utilization occurred.

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Table C

ISM-II
O&M EQUIPMENT TRIAL
TRACTOR UTILIZATION SUMMARY

Provinces & Divisions	SEP.91 Tractor hrs during month	OCT.91 Tractor hrs during month	NOV.91 Tractor hrs during month	DEC.91 Tractor hrs during month	JAN.92 Tractor hrs during month	FEB.92 Tractor hrs during month	MAR.92 Tractor hrs during month	APR.92 Tractor hrs during month	MAY.92 Tractor hrs during month	JUN.92 Tractor hrs during month	JUL.92 Tractor hrs during month	AUG.92 Tractor hrs during month	SEP.92 Tractor hrs during month	OCT.92 Tractor hrs during month	NOV.92 Tractor hrs during month	DEC.92 Tractor hrs during month	TOTAL Hrs EQUSED UPTO DATE	%AGE ** UTILIZATION UPTO DATE
PUNJAB (17 units)																		
Lahore Div.	154	142	31	0	0	87	369	178	127	81	RNA	RNA	RNA	RNA	RNA	RNA	1169	29
Kirana Div.	199	244	140	97	95	58	189	162	268	338	422	335	362	402	333	363	4007	53
Multan Div.	368	505	390	350	40	273	101	40	0	0	0	45	180	231	274	161	2958	48
Bahawalpur Div.	73	311	251	218	455	411	308	273	186	280	155	163	486	365	348	196	4479	75
PROV.TOTALS	794	1202	812	665	590	829	967	653	581	699	577	543	1028	998	955	720	12613	51
SINDH (12 units)																		
Fuleli Div.	NA	74	397	387	372	296	299	297	207	204	208	79	39	232	65	90	3246	60
Hala Div.	NA	146	133	143	217	100	150	143	145	138	135	136	135	147	117	12	1998	39
Jamrao Div.	NA	0	214	180	195	118	501	516	407	482	411	312	383	294	163		4176	75
PROV. TOTALS	NA	220	744	710	784	514	950	956	759	824	755	527	557	673	345	102	9420	57
BALOCHISTAN (5 units)																		
Jal Pal Div.	NA	NA	NA	572	147	209	225	499	357	368	412	450	230	338	259		4066	73
PROV. TOTALS	NA	NA	NA	572	147	209	225	499	357	368	412	450	230	338	259		4066	73
NWFP (4 units)																		
Southern Canal Circle	NA	NA	NA	NA	NA	NA	NA	97	60	90	55	40	70	85	150	2	649	18
PROV. TOTALS	NA	NA	NA	NA	NA	NA	NA	97	60	90	55	40	70	85	150	2	649	18
PROJ.TOTAL	794	1422	1556	1947	1521	1552	2142	2205	1757	1981	1799	1560	1885	2094	1709	824	26748	*** 53

NA : Period not counted in analysis due to late supply of equipment or due to readjustment in equipment distribution.
RNA: Record not available.
** Percentage utilization is based on 100 hrs/month/tractor target for the No of months tractor is physically used.
*** This is the weighted average.

Utilization in Sindh and Balochistan dropped off because of exceptional rains in August and flooding in September but then increased with flood repair work. Utilization in NWFP was low primarily due to frequent turnover of personnel and reassignment of equipment.

There was some nonproductive use of the equipment. Nonproductive use is defined as time the tractor was running but not doing any work. Nonproductive use includes idling time, moving to and from the job, and, in some cases, unauthorized use. The ratio of nonproductive use is high in Balochistan because of the distance required to be travelled to obtain diesel fuel and inability to store fuel on site. For detailed calculations on tractor utilization refer to Annex V.

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Implement Utilization

Implement use data was extracted from Form B. A province wise summary of implement use is given in Table D below.

TABLE D

PROVINCE WISE SUMMARY IMPLEMENT UTILIZATION

PROVINCE	TOTAL UTILI ZATON (HRS)	PRODU CTIVE USE (HRS)	IMPLEMENT USE HOURS					
			FEL	CP	DB	GB	TT	ST
PUNJAB	12613	11653	794	318	5029	4206	844	462
SINDH	9420	8961	460	231	3183	2038	1969	1080
BALOCH	4066	3207	32	24	469	1764	214	704
NWFP	649	530	0	0	90	20	380	40

CP = Chisel Plough
DB = Dozer Blade
TT = Tipping Trolley
FEL = Front Loader
GB = Grader Blade
ST = Sprinkling Trailer

A summary of the hours of use of each of the implements supplied in each divisions' equipment package is given in Table E. Since only one implement can be used at a time, the total implement hours in a division equals the total productive hours of the tractors. The relative percentage of time each implement is used is also given on a provincial basis. For more details' see Annex VI.

The frequency of use of implements varied between provinces primarily due to different types of work being done. In Punjab and Sindh, work was oriented toward repair of canal banks, leading to high use of the dozer blade. In Balochistan, the equipment was used primarily for routine maintenance of the canal bank roadway, leading to heavy use of the grader blade and sprinkler trailer. In NWFP, the equipment was used primarily for hauling earth and gravel. The indicated low level of utilization of the chisel plough and front-end loader is misleading in that these implements were supplied only with the one XEN's package as compared with the others which were supplied to three or four subdivisions in each division. The XENs' packages also tended to be less utilized than the SDOs' packages. It was the consensus of users that all of the implements are useful, and that chisel ploughs should be supplied with SDOs' packages as well.

TABLE E

SUMMARY OF IMPLEMENT USE BY DIVISIONS

ISM-II
O&M EQUIPMENT TRIAL
IMPLEMENT UTILIZATION SUMMARY

Provinces & Divisions.	Total No of hrs tractor was used	NPU plus idle hrs of the tractor	Productive hrs of the tractor	XEN's & SDO's TRACTORS					
				FEL Hrs	CP Hrs	DB Hrs	GB Hrs	TT Hrs	ST Hrs
PUNJAB									
Lahore Div.	1169	462	706	0	0	365	302	0	39
Kirana Division	4007	45	3962	156	63	2112	1339	224	68
Multan Div.	2958	141	2817	252	89	1164	1121	162	29
Bahawalpur Div.	4479	311	4168	386	166	1388	1444	458	326
PROV:TOTALS	12613	959	11653	794	318	5029	4206	844	462
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				7	3	43	36	7	4
SINDH									
Fuleli Div.	3246	159	3087	281	163	1349	953	158	183
Hala Div.	1998	171	1827	0	0	890	426	0	511
Jamrao Div.	4176	129	4047	179	68	944	659	1811	386
PROV:TOTALS	9420	459	8961	460	231	3183	2038	1969	1080
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				5	3	36	23	22	12
BALOCHISTAN									
Jhat Pat Div.	4066	859	3207	32	24	469	1764	214	704
PROV:TOTALS	4066	859	3207	32	24	469	1764	214	704
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				1	1	15	55	7	22
NWFP									
SE. SCC.	13	13	0	0	0	0	0	0	0
Marwat C.DIV.	457	25	432	0	0	12	0	380	40
Bannu C.Div.	115	17	98	0	0	90	8	0	0
Paharpur C.Div.	64	64	0	0	0	0	0	0	0
PROV:TOTALS	649	119	530	0	0	90	20	380	40
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				0	0	17	4	72	8
Project Totals	26748	2396	24351	1286	573	8771	8028	3407	2286
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				5	2	36	33	14	9

ABBREVIATIONS:
i) FEL =Front end loader
ii) CP =Chisel plow
iii) DB =Dozer blade
iv) NPU =Non-productive use
v) TT =Tipping trolley
vi) GB =Grader blade
vii) ST =Sprinkling trailer

Financial Analysis

An analysis was made to evaluate the financial viability of the O&M equipment, using the data collected on Proforma B. This was done by comparing the cost of doing work with the O&M equipment with the cost of the same work if done through the traditional contracting practices.

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A brief cost comparison in each province is given in the Table F below. For a more detailed summary see Table G and Annex VIII.

TABLE F

PROVINCE WISE COMPARISON OF COSTS

PROVINCE	TOTAL UTILIZATON (HOURS)	COST @ Rs. 150/HOUR (MILLIONS)	COST OF CIVIL WORKS (MILLIONS)	CIVIL WORK COST/EQUIP -MENT COST
PUNJAB	12613	1.89	1.96	1.04
SINDH	9420	1.41	2.50	1.77
BALOCHISTAN	4066	0.61	2.11	3.42
NWFP	649	0.10	0.08	0.79

Table G

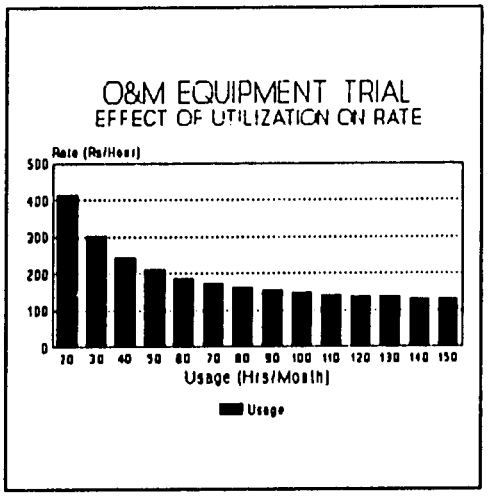
ISM-II
O&M EQUIPMENT TRIAL
COST ANALYSIS SUMMARY

Province, Division & Sub-division	Total No of hrs tractor used Hrs	Hourly rate of equip. Rs/Hr	Cost of equipment use Rs	Description of works performed and units: Earth work & its supply incl. 100 ft lead		Earth work supply incl. load in excess of 100 ft.		Grading levelling and prep. of earth. roads 10 ft wide		Silt clearance from canal beds		Sprinkling of water on canal and drain inspection tracks		Rehandling of earth, load up to 50 ft.		Transport of material		Total cost if contracting of same work on schedule rate is done
				Quant (1000 cft)	Cost Rs.	Quant. (1000 cft)	Cost Rs.	Quant. Equv. 1000sft	Cost Rs.	Quan (1000 cft)	Cost Rs.	Quant. Equv. 1000sft	Cost Rs.	Quant (1000 cft)	Cost Rs.	Quant 100 cft	Cost Rs	
PUNJAB																		
Lahore Div.	1169	150	175350	58	11340	77	16194	2150	93255	0	0	1410	5640	0	0	0	0	129129
Kirana Div.	4007	150	601050	730	143020	436	165925	4555	184452	150	12584	3215	16075	0	0	0	0	522056
Multan Div.	2958	150	443700	210	41208	672	177144	1590	71184	0	0	490	1960	0	0	0	0	291496
Bahawalpur Div.	4479	150	671850	383	75106	145	60419	16895	756389	442	77700	9224	46120	0	0	26	3900	1019634
Prov. Totals	*12613*	150	*1891950*	*1382*	*270674*	*1330*	*419682*	*25190*	*1108280*	*592*	*90284*	*14339*	*69795*	*0*	*0*	*26*	*3900*	*1962615*
PERCENTAGE OF TOTAL COST					*14*		*21*		*56*		*5*		*4*		*0*		*0*	CIV/TR=1.04
SINDH																		
Fuleli Div.	3246	150	486900	502	127619	111	81949	6842	361626	0	0	6065	30325	0	0	0	0	602519
Hala Div.	1998	150	299700	266	67489	160	43926	18455	978115	46	9616	39235	196175	4	508	0	0	1295829
Jamrao Div.	4176	150	626400	84	21395	627	286178	3640	192920	0	0	9656	48280	349	44277	100	11877	604027
Prov. Totals	*9420*	150	*1413000*	*852*	*216503*	*898*	*412053*	*28937*	*1533661*	*46*	*9616*	*54956*	*274780*	*353*	*44785*	*100*	*11877*	*2503275*
PERCENTAGE OF TOTAL COST					*9*		*16*		*61*		*0*		*11*		*2*		*0*	CIV/TR=1.77
BALOCHISTAN																		
Jal Pat Div.	4066	150	609900	69	40503	62	74828	30429	1859283	0	0	27645	138225	0	0	0	0	2112839
Prov. Totals	*4066*	150	*609900*	*69*	*40503*	*62*	*74828*	*30429*	*1859283*	*0*	*0*	*27645*	*138225*	*0*	*0*	*0*	*0*	*2112839*
PERCENTAGE OF TOTAL COST					2		4		88		0		7		0		0	CIV/TR=3.46
NWFP																		
Three Divs	649	150	97350	0	0	119	48325	618	27668	0	0	150	600	0	0	0	0	76593
Prov. Totals	*649*	150	*97350*	*0*	*0*	*119*	*48325*	*618*	*27668*	*0*	*0*	*150*	*600*	*0*	*0*	*0*	*0*	*76593*
PERCENTAGE OF TOTAL COST					*0*		*100*		*0*		*0*		*0*		*0*		*0*	CIV/TR=0.79
Project Total	*26748*	150	*4012200*	*2303*	*527680*	*2409*	*954888*	*85174*	*4528892*	*638*	*99900*	*97090*	*483400*	*353*	*44785*	*126*	*15777*	*6655322*
PERCENTAGE OF TOTAL COST					*8*		*14*		*68*		*2*		*7*		*1*		*0*	CIV/TR=1.67

Note CIV/TR = Cost of civil works/cost of tractor use to do these works.

A provisional hourly rate of Rs 150/hour was derived for the use of O&M trial tractor with implements. In calculating the rate of Rs 150/hour, an average tractor utilization rate of 100 hours/month was assumed, whereas the recorded average utilization rate over the trial period was actually 53 hours/month. At this lower utilization rate, the hourly cost of operating the equipment would be higher primarily due to the fixed cost of amortization, with corresponding reduction in the comparative cost ratio. The higher utilization rate was used because it was considered reasonable to assume that when the use of the equipment became fully institutionalized, the utilization rate would approximate the target rate.

Utilization level has a direct effect on the per hour rate of the equipment. Recommended hourly life or recommended life in years, which ever completes first has been considered in the calculations for determining the amortization cost of the trial equipment. Compound interest at the rate of 10%, maintenance charges at the rate of 5% of capital cost per annum, and salvage value of the equipment at the rate of 10% of the capital cost at completion of the useful life are considered in the rate calculation. Capital recovery factors adopted in the per hour cost will return the capital cost of equipment over its effective life. Variable operational cost of the equipment is also accounted in the per hour usage cost.



A range of hourly rates was calculated considering 20 to 150 hours/month usage. The rates are plotted against the utilization levels in the graph. The graph reveals that the hourly rate rapidly increases when monthly usage drops to less then 50 hours and gradually reduces beyond 50 hours/month usage. For hourly cost calculations, see Annex VII.

Contractual cost of the works is based upon the prevailing works rates in each province. Data for the quantities of the works accomplished was collected from records provided by the PIDs and also monitored during field visits by TA Team members. Quantities of work performed, their applicable rates, and the cost of each work was worked out at subdivisional level. This data was collected at divisional, provincial, and project level. The different types of work are shown in terms of cost according to schedules of rates, since the physical quantities of each type of work are in different units.

The indicated overall project total for work alone by O&M

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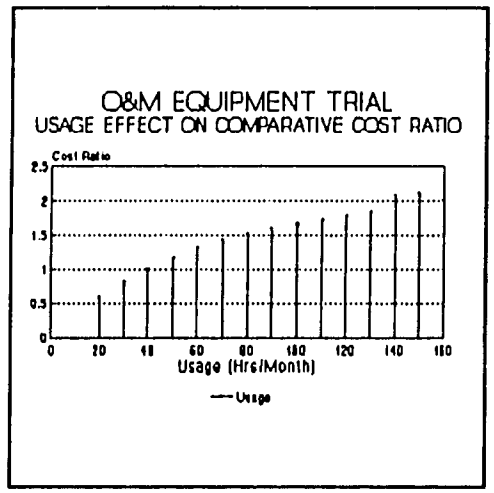
equipment is Rs 4.01 million and by contract, Rs 6.66 million. This indicates a provisional comparative cost ratio of about 1.67. For more details see Annexure VIII.

The relationship of utilization level to the comparative cost ratio is shown graphically. It can be seen from the graph that the ratio reaches unity at a fairly low level of utilization. As utilization is increased, the cost ratio increases proportionally. It can also be seen that the recommended 100 hours/month/package rate gives a cost ratio substantially higher then unity.



Pre and Post Analysis

Form C relates to the physical condition of the canals and drains before and after use of trial equipment. However, the input from the executing officers to Form C was very sparse. Also, it was not within the potential of the TA monitoring team to make this field evaluation. Superintending Engineers participating in the final evaluation workshop were asked whether the channels, canal banks, and canal roads in the trial divisions in their circles were in a bettter state of maintenance at the end of the trial than in other divisions in their circles. The responses were universaly positive. It was also reported that the mobility of the staff was enhanced which resulted in decreased response time to emergency situations.

Users Opinions

Almost all XENs, SDOs, and subengineers participating in the trial were interviewed near the end of the trial period using a standard questionnaire. The observations of the respondents were recorded on the questionnaire forms. A summary compilation of the results of the questionnaire survey and of other monitoring activities of the TA team is given below.

i) Arrangement of necessary funds for operation of O&M trial equipment remained the foremost issue. In response to the questionnaire, 88 percent of units in Punjab, 100 percent in NWFP, and 10 percent in Sindh felt that they had not had enough funds for the operation of O&M trial equipment.

ii) Use of the trial equipment has not been adopted as a part of routine departmental activity. Specific directives have not been

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issued to the end users about the procedures for allocation of funds, record keeping, progress targets, progress monitoring, policy for hiring staff, and directives related to the other aspects of use of the trial equipment. However, supervisors provided undocumented instructions to the subordinate staff for operating the equipment. Such instructions have been nullified occasionally by transfer of supervisors and, in many cases, by the finance people. Necessary guidelines have not been issued to the trial divisions for use of existing M&R funds for O&M trial equipment operation. At a later stage, 4 to 8 months after supply of equipment, some divisions were allowed to use M&R funds for operation of trial equipment.

iii) In general, work plans were prepared by the SDOs (with the assistance of the TA Team). Work plans were approved in many cases, though after some delay. None of the trial divisions, except in Balochistan, followed the work plans. Shortage of funds was the main reason given, but lack of administrative follow up may be another.

iv) O&M trial related meetings were conducted by most XENs with their subordinate staff, but no written instructions were issued following such meetings. The oral instructions issued in the meetings left the subordinate staff uncertain about implementation as they were not confident that these instructions would not be superseded, which did happen in some cases.

v) Trial divisions were confused about documentation of expense accounts for use of O&M trial equipment, primarily because machinery use is not customary in civil divisions. This is still the case in some divisions in spite of the coordination discussions arranged by the TA team between equipment users and senior officers.

vi) Equipment utilization during the trial period was not uniform, primarily due to the interrupted flow of operational funds, lack of timely management decisions, and the different levels of interest of personnel involved in the trial program.

vii) There seemed to be a lack of coordination between XENs and SDOs, resulting in lack of use of XENs' tractors, including front end loaders and chisel ploughs, which were intended to be used on an as-needed basis by the respective SDOs. Records of the XENs' tractors are also not well maintained and in some cases, not available.

viii) The equipment in general proved effective. However, there were some minor problems like cracks on frames of the front dozer and rear grader blades. The supplier is removing these deficiencies without any additional cost. In response to the questionnaire, 100 percent of users in Punjab, Sindh, and Balochistan described the equipment as effective.

ix) Users described the tractor horsepower as adequate in 100 percent of cases in Punjab, 80 percent cases in Sindh, and 50 percent in Balochistan. The remaining units feel that tractor horsepower is inadequate for the dozer blade, particularly while working in hard soil conditions. In NWFP, tractor horsepower was assessed to be insufficient for the dozing of gravel (which was not an intended use). It was unanimously recommended at the March workshop that chisel plows, which are included with the XENs' packages also be included with the SDOs' packages to loosen soil for dozing.

x) A few instances of equipment misuse have been identified. The misuse appears to be mainly politically influenced.

xi) The following types of activities were performed:

- Supply of earth within 100 feet distance, including all support actions,
- Supply of earth exceeding 100 feet distance, including all support actions,
- Desilting of canals,
- Grading of earthen embankments,
- Sprinkling on earthen embankments,
- Rehandling of excavated material, and
- Haulage of materials other than earth.

xii) The above listed activities were used to perform the following works:

- Closure of breaches,
- Repair to damaged banks,
- Maintaining freeboard,
- Desilting,
- Maintenance of inspection tracks,
- Clearing of the silt from canal and drain banks, and
- Supply of material for general repair.

xiii)The equipment has proved to be very useful for emergency repairs to canal systems, particularly because of its immediate availability. Also, effective use of equipment was made in support of flood relief duty.

xiv) No major implement or tractor breakdown was reported. One reason for no breakdown is probably that the equipment was new.

xv) All units had adequate access to the authorized dealers and open market for purchase of service/repair spare parts.

xvi) All units have stated that their M&R capability has improved after provision of trial equipment. Also, the equipment's flexibility for conjunctive use with the existing labor resources was noted as an advantage.

xvii)All trial units recommended that similar equipment should be provided to all divisions in all PIDs. Addition of a chisel plow and wheel mounted tractor drawn scraper was also recommended. NWFP units recommended provision of heavy equipment like clamshell, etc., to overcome their desilting/degravelling problem at Baran Dam site.

xviii)Flat bed trucks remained either idle or their use was extremely low. Some usage of trucks was made during flood emergency for long distance shifting of labor and earth haulage work. Trucks were not used for trial equipment shifting in any case. One reason for low utilization was delay in registration of the trucks.

xix) Vehicles other then trucks have been intensively used. However, the actual utilization of vehicles in direct support of the O&M trial was low.

xx) The utilization of motorcycles for use of subengineers had increased towards the end of the trial program.

In summary the analysis has shown that the equipment package is effective and economical for performing routine maintenance and emergency repairs of canal banks. Some minor modifications are desirable. Utilization during the trial period was low primarily because the slow pace of institutionalization. It can reasonably be expected that light mechanized equipment would be efficiently utilized if standard procedures are established for administering and budgeting.

V. EVALUATION AND RECOMMENDATIONS

The trial clearly demonstrated that the equipment is effective for routine maintenance and for repairs. It is especially useful for emergency repairs of canal breaches and flood damages. It is economical in comparison to traditional methods, providing a reasonable level of utilization is achieved. Divisions participating in the trial were judged to have achieved a better state of maintenance than other divisions in the same circles. Most of the problems were institutional or budgetary but high level PID officials offered assurances that these problems can be resolved.

Evaluations and recommendations in terms of specific issues are given below. These evaluations and recommendations represent the consensus of the Technical Assistance Team, executing officers participating in the program, and senior representatives of the Provincial Irrigation Departments.

I. Equipment Package

Definition

A light farm tractor based equipment package has been provided to 29 irrigation sub-divisions and divisions of the four irrigation departments. The package was carefully designed, as the selection and agreement on each item of the package was done in series of meetings with the Provincial Irrigation Departments.

The trial should determine problems/uses/advantages of each piece of equipment and whether there are any changes needed in the equipment package to make it more effective.

Evaluation and Recommendations

SDO's Package:

There is almost universal agreement that the equipment package provided to the subdivisions is effective for performing routine maintenance and emergency repairs of canal banks. All tractor and implement component of the SDO's package were well utilized and found to be adequate for their intended use, and some unintended uses. As noted below, SDOs expressed the need for their own chisel plough to break up hard earth for dozing and grading. Although supplied too late to be tested as a part of the SDO's package, it is certain that the chisel plough will increase the effectiveness of the package. Participants in the trial also proposed the addition of a small self-loading, wheel-mounted scraper, such as

used for agricultural land levelling, for carrying and spreading earth. Scrapers were provided to two subdivisions too late in the trial for evaluation. Since only one implement can be used with the tractor at a time, the hourly operation cost increases with each additional implement. Therefore, before adding a scraper to the package, the use of the two scrapers supplied should be evaluated and consideration should be given to whether any other implement, especially the tipping trolley should be deleted.

XEN's Package:

In general, the XEN's package remained underutilized in all the four provinces during the trial program. The chisel plough, which was not included in the SDOs' package, was indicated as being useful in the subdivisions. Since, the bulk of the work was accomplished without use of the XEN's package, it can be deleted without significant effect on a mechanization program.

Tractor Power:

Tractor horsepower has been evaluated as adequate, though some users described it as inadequate. This was particularly true in cases for the dozer blade, while working in hard soil conditions. Near the end of the trial, chisel ploughs were provided to all subdivisions to loosen earth, if necessary, before using the dozer or grader blades. With this addition, tractor horsepower should be adequate for intended uses.

Breakdowns:

No major tractor or implement breakdown was reported. Some minor modifications were required in the design of front dozer and rear grader blades to avoid possible cracks in their frames.

Vehicles:

The Suzuki jeeps and pickup trucks were definitely useful in the subdivisions. Better mobility and higher efficiency were reported. However, these vehicles did not work in conjunction with the equipment package and are not an integral part of the package. Flat bed trucks were essentially unutilized for several reasons. They were delivered late in the trial as part of the XENs' packages, which were generally under utilized. The trucks were also too large for use on many of the canal bank roads. It was found that the tractor-trolley combination provided the needed mobility for the equipment and the associated personnel. Motorcycles, also introduced late and to only some of the divisions, proved useful to subengineers for mobility, but they, too, were not found to be an integral part of the equipment package.

It is recommended that the equipment package be only supplied to the subdivisions. The SDO package may be modified by deleting the Suzuki jeep and pickup truck and by adding the chisel plough.

The recommended package which should be supplied to each sub-division is as follows:

a)	50 HP tractor	1
b)	Front end dozer blade	1
c)	Rear end grader blade	1
d)	Chisel plow	1
e)	Tipping trolley	1
f)	Water sprinkler trailer	1

It is also recommended that motorcycles should be provided to each subengineer for their mobility except in NWFP. The other vehicles, such as, the Suzuki jeep and pickup truck, while undoubtedly useful, did not prove to be an essential part of the package.

II. Financial Viability

Definition

The mechanization program should be financially viable. It would be desirable that the cost of work performed using the O&M equipment would be cheaper than the cost of the same work performed through the traditional contracting practices.

The trial should determine whether the mechanization program is financially viable and self-sustaining.

Evaluation and Recommendations

An analysis was made to evaluate the financial viability of the O&M equipment by comparing the cost of doing work with the O&M equipment and the cost of the same work if done through traditional contracting practices.

A provisional hourly rate of Rs 150/hour was derived for the use of O&M trial tractor with implements. This rate covers amortization of the cost of equipment and its operation and maintenance cost, providing for a self sustaining program. However, the hourly cost of the O&M equipment is dependent upon the rate of its utilization. For the calculation purposes, an average tractor utilization rate of 100 hours/month was taken.

The comparative analysis of doing work with the O&M equipment and by contract indicated a provisional comparative cost ratio of about 1.67. Even at lower utilization rates, mechanization is financially attractive.

III. Equipment Utilization

Definition

One of the objectives of the trial program is to evaluate the use of tractor and each item in the package. A decision is to be taken as to what equipment is to be deleted depending on its usefulness and it is to be determined as to what level of utilization were achieved for each piece of equipment.

Evaluation and Recommendations

Average tractor utilization for the four provinces was 53 percent. The range is from 18 percent to 73 percent. The low tractor utilization was affected by various factors in the provinces foremost being shortage of funds.

The utilization of implements varied primarily due to different types of work being done in the provinces e.g. in Punjab and Sindh, work was oriented towards repair of canal banks whereas in Balochistan, the equipment was used primarily for routine maintenance of the canal bank roadway. In NWFP, the equipment was used primarily for hauling earth and gravel.

The XEN's package also tended to be less utilized than the SDO's package due to lack of coordination between the two offices. It was the consensus of the users that all of the implements are useful and that chisel plough should be supplied with the SDO's package as well. As recommended earlier, the XEN's package should not be included in a mechanization program.

IV. State of Maintenance

Definition

It is expected that the divisions which are under the trial program would show improvements in many areas of O&M works.

The evaluation should be able to differentiate on the state of maintenance and other factors related to divisions with the trial program as compared to divisions without trial program.

Evaluation and Recommendations

It was observed and then confirmed by the attending SEs at the final workshop that the condition of channels, canal banks and the roads were comparatively better in the divisions with O&M Equipment than in divisions without O&M Equipment.

The other factors that made a difference in the divisions with O&M Equipment are:

a) Better mobility for labor using tractor and trolley.

b) Decrease in response time to emergency situations.

c) Enhancement in the efficacy and performance of O&M.

d) Improved output from existing labor force.

e) Reduction in number of breaches from the previous year, although exact data on this factor has not been provided.

V. Establishment of Funds

Definition

It is anticipated that lack of funding to operate O&M equipment may effect its utilization and use.

What must be done to ensure funds for equipment operation.

Evaluation & Recommendations

The results of trial and consensus reached at the final evaluation workshop clearly demonstrated that funding allocation and release procedures were major issues that affected equipment use and utilization in every subdivision in the trial program.

It was observed that in many occasions funding was not available to the subdivisions for the operation of equipment. In some cases, funding was made available but lacked release procedures.

It is recommended that special allocation of funds for operation and maintenance of O&M equipment be made in the budgetary allocation for M&R. The budget demand for this allocation should be supplemented with details of the tasks in workplan approved by the competent authority.

Approval should be given for the use of suspense account for equipment operation. This approval may not be necessary in all provinces, but modification should be made accordingly.

An average subdivisional budget for M&R is about Rs. 500,000 per year. The recommended operational budget for a package supplied to the subdivision is about Rs. 90,000 per year. This is based on recommended 1200 hours usage per year per tractor at an operational cost of about Rs 75/hr.

Thus the current subdivisional budgets are adequate for the equipment operation and would not require any upward revision, provided that the current levels are maintained.

VI. Mechanized Equipment in Civil Divisions

Definition

Traditionally, machinery and heavy equipment come under the Mechanical Divisions of the Irrigation Departments and are loaned to Civil Divisions on request. The maintenance and repair of this equipment is done through the irrigation workshops under the Mechanical Divisions.

It should be determined if the O&M equipment should be kept at the disposal of Civil Divisions and whether they are competent to control, supervise and maintain it, independently.

Evaluation and Recommendations

Although, traditionally, all machinery and heavy equipment come under mechanical divisions, it is believed that O&M equipment under the control of civil divisions is desirable for many reasons. These include: easy accessibility, decrease in response time during emergency, minimizing time required for closing a breach, and elimination of administrative burden and higher cost of outside contracting for routine and emergency works.

Mechanized equipment in possession of civil divisions is not a new concept in the Irrigation Departments. The divisions have motor vehicles under their control and therefore are accustomed to maintain, repair and purchase of POL.

Maintenance of O&M equipment by the civil divisions is not seen as a serious problem. The consensus reached at the final evaluation workshop concluded that equipment maintenance is not an obstacle, since small workshops for MF-240 type tractors already exist in the private sector close to the departmental sub-divisions. It is also expected that on expansion of the program many more workshops would come up in the private sector. There is also a possibility that civil circles would hire a foreman, on a work charge basis, to look after equipment for that circle.

The control of O&M equipment would make civil divisions self-sufficient and independent. It would also ensure an efficient use of machinery in conjunction with or in addition to the existing resources, such as manual labor.

VII. Full-Scale Mechanization

Definition

For the mechanization program to be successful and beneficial, it is necessary to regularize or institutionalize the program within the Irrigation Departments.

It must be determined as to what level of effort is required to regularize a full-scale mechanization program.

Evaluation and Recommendations

Regularization or institutionalization of a maintenance mechanization program would require efforts on behalf of irrigation officers at all levels. The foremost is a policy decision and directive at the highest level (the Secretary) of the Irrigation Department. This policy directive should be communicated, in writing, to all concerned offices, both within and outside the department, such as Provincial Finance Department. The directive should be executed by the concerned Chief Engineers directly for a period of one year or until the time when the program is fully regularized. The policy directive should include:

- Allocation of funds initially at Rs. 90,000/unit,
- The fund demands should be supported by the specific tasks in the workplan, duly approved by the competent authority,
- The allocated fund should only be used to support operation of the O&M equipment, and
- Additional allocations should be made under suspense acount, where it is used before charging the M&R costs to the actual schemes (Punjab).

The establishment of funding procedure is imperative before the execution phase begins. In this connection, not only the allocation of funds is necessary but the release of these funds for O&M operation needs to be streamlined. It is also necessary to establish a mechanism for hiring and adequately compensating equipment operators. It was the consensus of high-level PID representatives that an amendment to the current Finance Regulation 1990 would be desirable to allow hiring operators on a work-charge basis for more than six months.

A reporting mechanism should be established to monitor equipment operation. Monthly progress reports of equipment utilization should be submitted by the executing officers to the SE incharge. Yearly work plans for each subdivision, reflecting financial implications in the Budget Demand, should be prepared and submitted before June of each year.

VIII. Management and Policy Level Decision

Definition

The mechanization of routine maintenance is a new concept in the Irrigation Departments. Introduction of new concepts in any government organization may require policy decisions at several levels.

Evaluation and Recommendations

The consensus at the final workshop was that there are no major policy level decisions needed to be made for initiating the mechanization program. A high level policy directive (from the Secretary) and execution of this policy directive by the Chief Engineers would give incentives to the executing officers at the subdivisional level. It is anticipated that in some provinces, an approval from the Provincial Finance Department may be required to make necessary amendments to existing rules. This amendment would be to allow employment of work charge employees for more than a six-month period.

XI. Expansion of Mechanization

Definition

After one year of the trial program in all the four Provincial Irrigation Departments, a decision will be made as to whether to continue the mechanization program by expanding it to other divisions or to discontinue it due to operational and institutional problems.

A consensus should be reached by the four Irrigation Departments on the future of mechanization program.

Evaluation and Recommendations

Based on the consensus reached at the Final Evaluation Workshop, responses on the questionnaire distributed to the trial subdivisions and results of the one-year trial program, it is recommended that the mechanization of routine maintenance should be expanded to all irrigation divisions having conventional earthen canals. This expansion should consider the recommendations made in the text of this report on:

a) Equipment package mix,

b) Financial viability of the equipment operation ,

c) Funds required for equipment operation,

d) Utilization levels of tractors and implements.

X. Assurances to Potential Donors

Definition

If the trial program is successful, the PIDs would like to expand the mechanization program to all the civil divisions. This can either be done through self-financing or through donors who would be willing to provide funds for the O&M equipment.

In case donors are to be involved in the expansion program, how can assurances be given to the donors for adoption and utilization of the program.

Evaluation and Recommendations

The O&M Equipment Trial Program has clearly demonstrated that PIDs are desirous for mechanization of routine maintenance and are prepared to make commitments necessary to obtaining full benefits of mechanization. Factors such as low tractor utilization in NWFP, under utilization of XEN's package and shortage of funds in certain subdivisions should not be considered as a failure of trial program. Rather, these issues provide information and guidance for establishment of an effective mechanization program.

Funding, in general, is seen as a common problem in the Irrigation Departments. The analysis shows that a low utilization or non-utilization of equipment is directly related to low funding or non-availability of proper funding procedures with the executing subdivisions. It was also noticed that in certain cases funds were made available but were not released due to administrative problems.

The representatives stated that the PIDs would agree to provide assurances to donors, in case the mechanization program is expanded, in:

a) committing funds for O&M equipment operation,

b) ensuring procedural amendments for the release of these funds,

c) hiring qualified operators,

d) establishing reporting procedures to monitor equipment utilization, and

e) full-scale regularization of mechanization program.

EVALUATION OF O&M MECHANIZATION PROGRAMIN THE PROVINCIAL IRRIGATION DEPARTMENTS

ANNEX I

Consensus Reached on O&M Equipment Trial in O&M Planning Workshop
3-4 December 1990

Consensus Reached on O&M Equipment Trial in Mid-Term Evaluation Workshop
2-3 March 1992

Consensus Reached on Final Evaluation Workshop
18 February 1993

CONSENSUS REACHED ON O&M EQUIPMENT TRIAL IN O&M PLANNING WORKSHOP

3-4 December, 1990

Q.1. How do we inform and get the involvement of the personnel in the subdivisions/divisions?

Response

- A provincial level workshop, in each province , with all the concerned SEs, XENs, one or two SDOs and few selected Sub-Engineers from each division will be held at a central location in order to carry out orientation, define the plans, and adopt methodology for implementation and monitoring. Provincial Coordinator, Provincial Advisor, representatives of TA team USAID will also participate in this workshop.

- Detailed meetings will be held at divisional level for program orientation and concept development. These meetings will be attended by all the involved staff from the division and representatives of TA Team/USAID.

- Prior training of subengineers and mates be undertaken in order to clear their concept and ensure full involvement.

Q. 2. Who should be responsible above the division level for implementation?

- SEs should be made in charge of the program and they should look into the matters of finances, training of staff, implementation of the program, work plans, maintaining of log books, etc. Provincial Coordinator will share responsibility for implementation.

Q.3. How can we monitor the performance/effectiveness of maintenance in the trial sub-divisions?

- Representatives of USAID, TA team and PIDs will develop a format/proforma for recording the performance and output of trial equipment.

- Monthly program of work giving planned use for each piece of equipment should be prepared and monthly performance/progress carefully observed against the established program/targets.

- The Provincial Coordinator should monitor the performance/ effectiveness of the equipment through his independent nominated officer. The maintenance condition of the equipment should be reported to the Provincial Coordinator by XEN Mechanical and his staff, staff holding the equipment, and TA team advisors.

Q.4. How can we evaluate the suitability of the specific pieces of equipment?

- The basis for evaluating the suitability of specific pieces of equipment will be the reports regularly submitted by the custodian/operating staff (XEN, SDO) of the trial equipment.

- The reports should essentially contain; quantum of work executed, hours of work machine used, cost of operation, and problems encountered in using the equipment.

- Evaluation for suitability will also be based on the careful examination of log books and observations on performance under specific conditions/limitations.

- For suitability evaluation, there is a need to find ways and methods for comparing the cost of routine works executed by machine and that done by manual labour.

Q.5. What data need to be collected and who should be responsible?

- The quantities of work done should be recorded in log books each day/occasion of use by the operator or Sub-Engineer. The entries should be checked occasionally by the SDO/XEN concerned.

- Data on work to be done as per plan, cost estimates for these works, contractor's prices for these works, actual quantities executed by a particular piece of equipment and actual hours of machine use for the executed quantities should be maintained.

Q.6. How should the evaluation be made in a way that is useful to both the PIDs and the donors? Who should review it?

- The evaluation should be done by an independent agency, designated by Provincial Coordinator and Zonal CE, in each region. The evaluation reports should be reviewed by the Zonal CE. An evaluation team comprising of Provincial Coordinator, Provincial Advisor, representatives of PID, USAID and TA team can ideally carry out evaluation task.

-The evaluation reports should also be reviewed in Equipment Task Force meetings.

CONSENSUS REACHED ON O&M TRIAL IN MID-TERM EVALUATION WORKSHOP
2-3 MARCH 1992

This chapter presents consolidated statements of the agreements and recommendations made about the issues discussed at the workshop. The actual records of the group sessions are given in Appendices A, B, and C. It must be noted that in several cases that workshop participants recommended action for additional procurements be taken by USAID. Due to budgetary constraints, no significant additional procurement by USAID for the O&M Equipment Trial Program will be possible.

INSTITUTIONAL

1. **Problem:** Frequent transfer of trained staff from the concerned divisions/subdivisions.

   Response: The PID authorities in respective provinces be briefed/informed about the importance of trial and requested not to order frequent transfers of staff affiliated with trial.

   Action By: Prov Coord, Secretary

2. **Problem:** Temporary assignment of operators.

   Response: Secretaries of respective PIDs may be requested to initiate the case with Finance Department for regular employment of operators. The operators should be either regular (S.N.E) or on work charge basis.

   Action By: Prov Coord, Secretary

3. **Problem:** Difficulty in appointing required staff in view of prevailing ban on new recruitment.

   Response: This is applicable to NWFP, Punjab and Sindh PIDs only. It was recommended that ban on employment of work charge should be lifted for this trial. Secretaries of the respective PIDs be requested to approach Chief Ministers to accord special waiver for appointing new staff.

   Action By: P C, Appointing Auth.

4. **Problem:** Additional Training for the Operators.

   Response: All the participants recommended that

Millat Tractors/T A team should arrange additional training of operators.

Action By: T A team/Millat

5. **Problem:** Improper distribution of vehicles.

Response: As far as Sindh PID is concerned, there is no problem of vehicles distribution. For other PIDs, Chief Engineers and Superintending Engineers concerned should resolve the issue in consultation with USAID authorities. If the need arises, respective Secretary Irrigation be requested to intervene personally and ensure the proper distribution of vehicles as per the provisions made under this program.

Action By: CEs/PCs/SEs & USAID

6. **Problem:** Used vehicles in poor condition supplied for the program.

Response: This problem pertains to Punjab PID only and it was mutually agreed that used vehicles supplied should be replaced by new ones.

Action By: PC/CEs/USAID

FINANCIAL AND ADMINISTRATIVE

1. **Problem:** Inadequate funding; proposed works can not be carried out with the available funding.

Response: Respective PIDs should take up this issue with their Finance Departments to allocate sufficient funds. The funds should be allocated as per the revised yardsticks. In case of Punjab PID, revision of Composite Schedule of Rates 1979 should also be undertaken.

Action By: Prov Coord/CEs/SEs

2. **Problem:** Lack of proper planning which is partly related with lack of expected funding.

Response: Participants view was that lack of funds hamper proper planning and execution of the program. In case of inadequacy of funds, the plans should be adjusted

according to availability of funds.

Action By: PIDs

3. **Problem:** Delayed sanctions of the estimates and delayed receipt of funds.

Response: Estimates should be prepared in time and timely release of adequate funds, Suspense Head, as well as O&M grant should be ensured by PIDs from their respective Finance Departments.

Action By: SEs/CEs

4. **Problem:** Different yardsticks/formulae for calculating R&M.

Response: The estimates should be prepared as per the estimate formats provided by Mr. Aslam Khan. It was also recommended that yardsticks/formulae for calculating R&M should be revised and standardized.

Action By: PIDs

MECHANICAL

1. **Problem:** Requirement of additional chisel ploughs.

Response: USAID be requested to provide chisel ploughs at subdivisional level.

Action By: USAID

2. **Problem:** Tractors at divisional headquarters are without front and rear blades.

Response: Tractors at divisional level should be provided with front and rear blades.

Action By: USAID

3. **Problem:** During operations, following defects have been observed in the equipment supplied:

   a. Problems with hydraulic systems, bursting of pipes, leaking of seals and valves.
   b. Problems with rear blade performance.
   c. Front blade lacks angle adjustments.
   d. Less traction of tractor wheels in marshy and soft surface areas.
   e. Lack of availability of spare parts at division headquarters locations.
   f. Inadequate length of sprinkler bar.
   g. Failures and cracks in welding of front blade hinges.
   h. Problematic towing hook.

   Response: Millat/JECO should be approached for rectifying all the mechanical defects/problems. Millat should ensure adequate supply of spare parts at divisional headquarter locations. T A team to coordinate and to provide detailed specifications after deliberations with the users.

   Action By: Millat/JECO

4. **Problem:** Inadequate H.P of tractors.

   Response: H.P of the tractor is adequate for Sindh PID. For other PIDs 75 H.P tractors be provided at divisional headquarters level.

   Action By: USAID

5. **Problem:** Need for flat-bed trucks.

   Response: Flat bed trucks should be delivered as soon as possible.

   Action By: USAID

6. **Problem:** Need for additional equipment at divisional level; excavator for desilting, hinge on tractor, dozer grader blade, backhoe, and scoop type scraper.

   Response: If possible, the listed equipment should be provided.

   Action By: USAID

7. **Problem:** Manual priming of water bowser pump is cumbersome

Response: A separate priming water tank of adequate capacity be provided with the main water tank.

Action By USAID

GENERAL

1. **Problem:** Political pressure on hiring operators/ drivers and assignment of equipment/vehicles.

Response: The participants were ultimately of the view that there is no problem on account of political pressure from any quarter.

2. **Problem:** Suzuki pickups not suitable; heavy duty vehicles are required.

Response: Heavy diesel pick ups be provided, because running cost for diesel vehicles is less and heavier vehicles last longer.

Action By: USAID

MONITORING AND EVALUATION

1. **Problem:** Forms are too difficult and complex for operators.

Response: Sub-engineers should be made responsible to fill the forms.

Action By: PIDs

2. **Problem:** Forms should be translated in Urdu.

Response: Participants from NWFP and Balochistan recommended that for their PIDs, simple formats should be provided with Urdu version both for estimation and record keeping.

Action By: T A team/PIDs

3. **Problem:** Complicated estimation procedures.

Response: Participants were of the view that no complications have been faced for estimation purposes. However, standard formats of estimates be provided/explained to all concerned.

Action By: T A team/PIDs

O&M Equipment Final Evaluation Workshop
Summary of Conclusions and Recommendations
18 February 1993

(Incorporating Comments from Mr. Shafaat Ahmed Qureshi, Chief Engineer Irrigation, Sargodha)

To reach a consensus on the final results of the monitoring program an evaluation workshop was held in Lahore on February 18, 1993. Senior representatives of the four Irrigation Departments were in attendance.

The purpose of the workshop was to obtain the contribution of senior officials and policy makers to the final evaluation of the O&M Equipment Trial.

The questions which were put to the groups for discussion included:

- Is the use of mechanized equipment by civil divisions desirable from the management and policy level? What are pros and cons?

- Are you aware of any improvement in level of maintenance in divisions with the equipment as compared to divisions without?

- Should the mechanization program be expanded to the other divisions? How can assurances of adoption and utilization be given to donors?

- What must be done to regularize a full-scale mechanization program?

- What procedures should be established to ensure funds for equipment operation?

This report is a summary of the consensus and agreements reached on the above issues and eventually will become an important part of the final evaluation report.

Question:

Is the use of mechanized equipment by civil divisions desirable from the management and policy level? What are pros and cons?

Consensus:

Mechanized Equipment in possession of civil divisions is not a new concept in the Irrigation Department. The divisions have motor vehicles, while some have been tractor and trolleys, under their control and therefore, are accustomed to operate, maintain, repair them and purchase of POL for them.

Maintenance of O&M equipment by the civil divisions is thus not seen as a serious problem. The consensus reached at the final evaluation workshop concluded that maintenance is not an obstacle, since small workshops for MF-240 type tractors already exist in the private sector close to the departmental sub-divisions. It is also expected that on expansion of the program many more workshops would come up in the private sector. There is also a possibility that civil circles/divisions would hire a Foreman, on a work charge basis, to look after equipment for that circle.

The control of O&M equipment would make civil divisions self-sufficient and independent. It would also ensure an efficient use of machinery in conjunction with or in addition to the existing resources, such as manual labor.

Question:

Are you aware of any improvement in level of maintenance in divisions with the equipment as compared to divisions without?

Consensus:

It was confirmed by the attending SEs at the workshop that the condition of channels, canal banks and the roads were comparatively better in the divisions with O&M Equipment than in divisions without O&M Equipment.

The other factors which made the difference in the divisions with O&M Equipment are:

a) Better mobility of officers and staff resulting in higher efficiency and better management.

b) Decrease in response time to emergency situations.

c) Enhancement in the efficacy and performance of O&M.

d) Efficient use of existing resources.

e) Reduction in number of breaches from the previous year, although exact data on this factor has not been provided.

Question:

Should the mechanization program be expanded to the other divisions? How can assurances of adoption and utilization be given to donors?

Consensus:

Consensus reached at the Final Evaluation Workshop, strongly recommended that the mechanization of O&M works should be expanded to the other divisions. This expansion should consider the following:

a) Equipment package mix

b) Financial viability of the equipment operation

c) Funds required for equipment operation

d) Utilization levels of tractors and implements

e) Institutional changes in the department

The representatives stated that the PIDs would agree to provide assurances to donors, in case the mechanization program is expanded, in:

a) committing funds for O&M equipment operation,

b) ensuring procedural amendments for the release of these funds,

c) hiring qualified operators on a work charge basis,

d) establishing reporting procedures to monitor equipment utilization,

e) full-scale regularization of mechanization program and

f) considering any other condition precedent set by them.

Question:

What must be done to regularize a full-scale mechanization program?

Consensus:

Regularization or institutionalization of O&M mechanization program would require efforts on behalf of irrigation officers at all levels. The foremost is a directive at the highest level (the Secretary) of the Irrigation Department. This directive should be communicated, in writing, to all concerned offices, both within and outside the department, such as Provincial Finance Department. The directive should be executed by the concerned Chief Engineers directly for a period of one year or until the time when the program is fully regularized.

The establishment of funding procedure is imperative before the execution phase begins. In this connection, not only the allocation of funds are necessary but the release of these funds for O&M operation need to be streamlined. In Punjab, amendments are required in the current Finance Regulation 1990, for hiring of the operators on work charge basis for more than 6-month period. Provincial Finance Departments should be approached for creation of a new budget head, specifically for O&M Equipment Operation, in the Non-Development Budget (NDB) of the PIDs. Approvals should also be taken for the use of suspense account for equipment operation. This approval may not be necessary in other provinces, but modification should be made accordingly. Attempt should be made to allocate funds for O&M equipment operation using yard stick criteria.

Reporting mechanism should be established to monitor equipment operation. Monthly progress reports reflecting equipment utilization should be submitted by the executing officers to the SE incharge. Yearly work plans for each sub-division, reflecting financial implications in the Budget Demand, should be prepared and submitted before June of each year.

Question:

What procedures should be established to ensure funds for equipment operation?

Consensus:

It was general consensus that the funding was the single major issue which effected equipment use and utilization in every sub-division under trial program.

It was observed that in many occasions funding was not available to the sub-divisions for the operation of equipment. In some cases, funding was made available but lacked release procedures because lowers staff was not yet conversant with the

accounting procedures for the work done under the mechanization program.

It is recommended that a separate Budget Head should be created in the Non-Development Budget (NDB, Demand 9) under M&R (Sec 6-52300). This would ensure a proper allocation and use of funds for O&M equipment operation.

Recommended operational budget for a unit supplied to the sub-division is Rs. 90,000 per year per sub-division. This is based on recommended tractor hours per year and tractor cost per hour. For more detail on this subject, see the main text of the this report.

EVALUATION OF O&M MECHANIZATION PROGRAM IN THE PROVINCIAL IRRIGATION DEPARTMENTS

ANNEXURE II

Technical Specifications of the Equipment

Defects Noticed During Monitoring

Technical Specifications of the Equipment

The original specifications for tractor and implements were as given below. Modifications made during the trial are described at the end of the orininal specifications and should be incorporated in equipment specifications for for expension program.

Item I. 50 HP TRACTOR

1. Attachments:

The tractor should be locally manufactured and by virtue of its design, should be capable of accepting and operating by its own power, the following attachments and implements:

- Front dozer blade
- Rear grader blade
- Hydraulic Tipping Trolley
- Water sprinkler trailer
- Front-end loader
- Chisel Plough/Scarifier

2. Engine

Diesel Fueled, 4 stroke cycle, 3 or 4 cylinders, 2100 to 2400 rpm water cooled, turbocharged or naturally aspirated with heavy duty radiator suitable for tropical conditions and fitted with manufacturer's standard fuel, air and oil filters. Air filter with per cleaner. Engine shall be capable of developing Brake horse Power at the engine fly wheel, of 45 to 55 HP (net), according to SAE, DIN or British Standards. Engine with full pressure filtered lubrication. Engine to have mechanical all speed governor.

3. Electrical System

Not less than 12 volts DC, tropically insulated. Heavy duty alternator and starter motor (to provide trouble-free service in field conditions). A heavy duty battery for diesel starting.

4. Transmission/Final Drive

Gear box, differential and final drive to provide not less than 8 forward and 2 reverse speeds. Final drive to have single reduction spur gears.

5. Main Frame: Integral and of welded construction.

6. **Hydraulic System**

Sealed and fully protected against contamination by dirt, and moisture. Cooling system with adequate capacity for tropical conditions. High pressure lines of mechanical steel tubing or abrasion and weather resistant wire braided hose or of strong synthetic/rubber material. Mechanical steel tubing will however be preferred. Draft and position control. Hydraulic system to have piston type or gear type pump.

7. **Tires**

Pressed wheel type, suitable for farm tractors, standard to the tractor model.

8. **Brakes:**

Efficient braking system, along with parking brake.

9. **Clutch:**

Dual or single plate dry type clutch suitable for operation of transmission and power take off.

10. **Power Take Off**

Manufacturer's standard Power Take Off to be provided with the tractor.

11. **Exhaust:** Vertical.

1_. **Lighting**

Front and rear lighting suitable for night driving and operation.

13. **Operator's Seat and Canopy**

Efficient and comfortable operator's compartment, with adjustable seat, back and arm rest providing easy access to instrument panel. A canopy with frame for protection from sun and rain, made of fiber glass or other suitable material.

14. **Counter-Weights**

Tractors with require counter weights during operation shall be supplied with counter weights.

15. **Draw-bar**

A versatile swinging draw bar shall be provided with tractor.

16. Fittings:

1. Fenders and protected lights
2. Horn
3. Indicator lights
4. Tool box with standard tool kit
5. Front pull hook (not provided)
6. Exhaust stack rain guard

17. Instruments and Gauges

Tractor to be equipped with the following instruments and gauges:

1. Engine oil pressure gauge
2. Cooling water temperature gauge
3. Ammeter
4. Hydraulic oil pressure gauge
5. Hour meter
6. Any other gauge/instrument standard to the manufacturer's tractor model.

18. Optional Equipment

1. Sun Canopy with frame
2. Counter weights (4 pcs)
3. Draw Bar

Item II. FRONT DOZER BLADE

1. Fitting:

Dozer Blade shall be front fitting on a locally manufactured 50 HP tractor.

2. Blade

Length 6 ft. Width 22 inches. Made of steel, of reinforced construction with reversible and replaceable cutting edge. Cutting edge size 6 inches x 0.5 inch made of high carbon steel.

3. Mounting

Blade to have heavy mounting brackets and strong rear frame for attachment to tractor facilitating easy drop off. Mounting shall permit angle or tilt dozing. Blade movement shall be minimum of 20 inches lift and 4 inches depth.

4. **Hydraulic System**

The blade to operate through single hydraulic rams, doubleacting operated by single lever hydraulic control valve from tractor seat.
Fully sealed and protected against contamination by dirt, dust and moisture.
High pressure lines shall be mechanical steel tubing, abrasion and weather resistant wire braided or of strong rubber/synthetic to withstand maximum pressure, at least 100% above working pressure.
Hydraulic cylinders with rust proof high quality industrial hard chrome plated ram shafts.
Rigid steel piping across front of tractor to give protection to the hydraulic system.

5. **Primer and Paint**

Complete unit to be rubbed down and sprayed with two coats of oil primer and final finished in paint of blue color.

Item III. REAR END GRADER BLADE

1. **Fitting**

Suitable for rear fitting with a locally manufactured tractor.

2. **Blade**

Length 6 ft. Made of steel, tubular frame, of reinforced construction with reversible and replaceable cutting edge. Cutting edge size 6 inches x 0.5 inch, made of high carbon.

3. **Mounting**

Mounting shall be three point linkage.
Blade pitch from 0 degree to 40 degrees and angle from 0 degree to 60 degrees either way in 20 degree increments.
Blade capability: multi-position 180 degrees off-set, either direction and completely reversible for back filling. Angle and pitch adjustable from the tractor seat. An alternative hitch pin for the right hand lower link shall be provided for ditching.

4. **Hydraulic System**

Blade to operate through single or twin hydraulic rams,

double acting operated by single lever hydraulic control value from tractor seat.
Fully sealed hydraulic system and protected against contamination by dirt, dust and moisture.
High pressure lines of mechanical steel tubing, abrasion and weather resistant wire braided or of strong rubber/ synthetics to withstand maximum pressure, at least 100% above working pressure.
Hydraulic cylinders with rust proof high quality industrial hard chrome plated ram shafts.

5. Accessories:

1. Grader wheel kit for fine grading
2. Blade extension kit
3. Side plate kit
4. Scarifier kit

6. Primer Paint

Complete unit to be rubbed down and sprayed with two coats of oil primer and final finished in paint of blue oil.

Item IV. HYDRAULIC TIPPING TROLLEY

1. Dimensions

Length 16 ft. Width 6.5 ft., and height 5 ft.

2. Capacity

Capacity 5 Tones: (To be towed behind a 50 HP tractor.

3. Trolley Body

Box size 9 ft. x 6 ft x 2 ft. mild steel body, all welded rear tipping and rear opening, supported on mild steel "U" profile pillars. Trolley bed of 10 SWG steel plate, and sides of 12 SWG steel plate.

4. Tipping

Arranged to be hydraulically operated from the tractor seat. When hitched to the tractor, the trolley to stand parallel to the level ground and not leaning forward.

5. **Main Chassis**

Ladder type main chassis, on 'U' profile mild steel pillars, all welded, channel size 6 inches.

6. **Tipping Chassis**

Ladder type of 'U' profile mild steel pillars, all welded, channel size 4 inches.

7. **Suspension**

Single axle steel tube of 4.5 inches x 3/8 inches. Suitable leaf spring suspension.(The leaf springs were deleted because of instability and changed to solid suspension)

8. **Wheels**

Fitted with two wheels of tubes and tires. Tire size and make to be 9.00 x 20, 14 ply. 'General' or equivalent.

9. **Towing Hook**

Eye Type, 5 inches diameter, swivel joints, made of forged steel.

10. **Brake**

Hand-operated mechanical brake for parking purposes.

11. **Lighting**

Two rear signal lights, two tail lights. Concealed encased wiring appropriately protected. Light reflectors on sides and rear installed.

12. **Hydraulic System**

Tipping mechanism to operate through single or twin hydraulic rams, double acting operated by single lever hydraulic control value from tractor seat.
Sealed hydraulic system fully protected against contamination by dirt, dust and moisture.
High pressure lines of mechanical steel tubing, abrasion and weather resistant wire braided or of strong rubber/ synthetics to withstand maximum pressure, at least 100% above working pressure.
Hydraulic cylinders with rust proof high quality industrial hard chrome plated ram shafts.
The tipping mechanism should be compatible with the hydraulic system of 50 HP Massey Ferguson model MF-240 tractors.

13. Landing Gear

Retractable, all metal, wheel type.

14. Primer and Paint

Complete unit to be rubbed down and sprayed with two coats of oil primer and final finished in paint of blue color. Lower structure of the body provided with anti corrosive treatment.

15. Spare Wheel

One spare wheel with tire and tube to be provided. Tire size shall be 9.00 x 20, 14 ply.

Item V. WATER SPRINKLER TRAILER

General Description: To be towed behind a 50 HP tractor. When hitched to the tractor, the trailer shall stand parallel to the ground and not leaning forward.
Specifications as follows:

1. Trailer Dimensions

Length: 14.5 ft., Width: 6.5 ft., and Height: 5 ft.

2. Water Tank

Capacity: 1,000 gallons, elliptical ends, of 12 SWG mild steel plate with a manhole covered with lid on top. Provided with auto-filling system off tractor P.T.O. With filling water pump C.F. 4 inches x 3 inches size, valves and hoses etc., mounted at the rear of the tank.
Also fitted, with water sprinkling system complete with on-off valve and sprinkler bar of 2 inch dia. G.I. pipe.

3. Chassis

Ladder type. 'U' profile mild steel pillars, all welded.

4. Suspension

Single axle steel tube of 4.5 inches x 3/8 inches size. Fitted with suitable leaf spring system.

5. Wheels

Trailer with two wheels with tubes and tires. Tire size: 9.00 x 20, 14 ply. Make: General or equivalent.

6. Towing Hook

Eye type, 5 inches diameter, swivel joint, made of forged steel.

7. **Brake**

Hand-operated mechanical brake for parking purposes.

8. **Lighting**

Two rear signal lights, two tail lights. Concealed encased wiring appropriately protected. Light reflectors on sides and rear provided.

9. **Landing Gear**

Retractable, made of all metal, and wheel type.

10. **Primer and Paint**

Complete unit including exterior and interior of the water tank to be rubbed down and sprayed with two coats of oil primer and final finished in paint of blue color. Under carriage and lower structure of the body provided with anti corrosive treatment.

Item VI. FRONT END LOADER ATTACHMENT

1. **Fitting**

Capable of front fitting on a Pakistan manufactured wheeled tractor of approximately 50 HP.

2. **Capabilities**

Minimum reach 7 feet on the ground and 3.5 feet at the maximum height. Digging capability of 6 inches depth. Lifting capacity at maximum height to be not less than 750 Kg. Bucket size 54 inches. Dumping angle from lever not less than 30 degrees.

3. **Mounting**

With parking legs for resting of the loader for its attachment and detachment to the tractor.

4. **Front End Loader**

Main frame, body and bucket made of M.S. steel welded box construction. Bucket fitted with strong digging teeth.

All pins provided with grease zerks.

5. **Hydraulic System**

Bucket hydraulically operated from one double acting hydraulic ram. Lift mechanism operated from two double acting rams. Sealed hydraulic system fully protected against contamination by dirt, dust and moisture.
High pressure lines of mechanical steel tubing, abrasion and weather resistant wire braided or of strong rubber/ synthetic to withstand maximum pressure, at least 100% above working pressure.
Hydraulic cylinders with rust proof high quality industrial hard chrome plated ram shafts.

6. **Primer and Paint**

Complete unit rubbed down and sprayed with two coats of oil primer and final finished in paint of blue color. Under carriage and lower structure of the body provided with anti corrosive treatment.

Item VII. CHISEL PLOW

1. **Fitting**

Suitable for fitting at the rear of a Pakistan manufactured wheeled tractor of approximately 50 HP.

2. **Chisel Plough**

Made of heavy mild steel box frame construction. With three replaceable tines designed to penetrate up to 20 inches into the ground. Tines with hardened and tempered carbon steel teeth.

3. **Hydraulic System**

Plough operated through a single or twin double-acting hydraulic rams, operated from the tractor.
Sealed hydraulic system fully protected against contamination by dirt, dust and moisture.
High pressure lines of mechanical steel tubing, abrasion and weather resistant wire braided or of strong rubber/ synthetic to withstand maximum pressure, at least 100% above working pressure.
Hydraulic cylinders with rust proof high quality industrial hard chrome plated ram shafts.

C-3: Offerors to submit their offers a list of dealers or distributors who maintain an inventory of spare parts and who will be responsible to provide after-sale service in all major cities of Pakistan.

DEFECTS NOTICED DURING MONITORING

During the monitoring of the equipment following defects were noticed with different implements.

I.Front Dozer Blade

Front dozer blade is attached to the frame which is bolted to the main body of the tractor. This frame has three portions. One portion is the under frame which is bolted under the body of the tractor. Similarly the second portion is also bolted under the front portion of the body of the tractor. The third portion is attached with the help of pins which allows the movement of the main frame with the help of front end of the ram (jack) provided to move the dozer blade up and down.

The rear end of the jack is fixed with the under frame bolted under the body of tractor. This is fixed with the help of the pin and allows the movement of the fixed end of the jack at that position.

During the course of monitoring, it was observed that some cracks had appeared in the main frame which operated the dozer blade.

The main frame which moves the blade up and down with the help of (ram) jack had shown cracks at the joints and at the points of weld.

Similarly the pins were worn out quickly because of constant rubbing of the same with the collars provided for the frames to move up and down. This had made the holes provided for the movement of the frames oval and also the pins had reduced in size at these points. This matter was discussed with M/S Jeco Ltd. who promised to carry out some repairs and modify the weak points where the frames had cracked. They have already carried out the repair and modifications to the dozer blade frame and fitted them back to the SDO's units in Punjab and they were replacing the dozer frames of the units in Sindh and Balochistan and NWFP as informed by them.

The cracks which appeared were noticed after 6 - 8 month of ruthless use of the front dozer blade by the operators.

II.Rear Grader Blade.

As already discussed heretofore, the rear grader blade is a multipurpose blade. This blade is fixed with the tractor with the help of three points hitch. This is provided with a semi circular plate with 5 No. holes in its front and one complete circular plate in the rear with holes . It is provided with main beam which is moved with the help of main pins around which this could be moved either way and the desired position of the blade could be fixed with the help of a pin provided for the purpose. The blade could be

extended to any desired side.

The position of the blade could also be fixed at any desired angle by removing the pin in the beam and circular plate and fixing position of blade at desired angle and fix the pin.

The rear circular plate has holes at 30° has interval. Main pin around which the angle to blade could be adjusted, carried the load of the rear blade. By constant use of the blade for hauling of the soil had made the rear main pin on the circular plate to crack around its weld.

The main cause of this crack was attributed to careless handling of the rear blade by the operators who did not bother about the tightening of the bolts of the grader blade and ensure that pins were not loose.

This point was also discussed with M/S Jeco who got all the pins repaired and the loose movement of the blade because of pins provided for the change of angle an extra circular plate with beam has been provided in the rear and two plates could be fixed with the help of bolts instead of pins so that blade does not work loosely damaging the rear main pin.

This change has already been carried out in almost all the rear grader blades in Punjab, Sindh, Balochintan and NWFP and strengthened accordingly.

III.Sprinkler Trailer.

1. The gear box attached to the P.T.O shaft of tractors needed to be checked again and ensure that the toe hitch pin could be locked properly, i.e. there was enough space between the hitch and body of the gear box so that draw pin could be locked with the pin.

2. The gear should form as one body with the tractor and does not become shaky when the same is used with auxiliary shaft to run the pump. This was possibly because of improper bolting arrangement of the gear box - with the body of the tractor. The management of Jeco have promised to look in to these difficulties and ensure that proper bolting arrangement was made where such a situation listed in two or three units who have been asked to refer to M/S Jeco to do the needful.

3. The draw hitch which is attached to the tractor to draw the trolley, sprinkler trailer, plate of 'U' holding the eye of hook of trolley trailers was not of proper thickness and would bend.

The manufacturers, JECO Ltd. were apprised of this situation. They have already changed all the draw hitches with a new properly stiffened hitches.

4. It was found that priming the tank-filling pump by use of buckets was cumbersome and time consuming. The manufacturer was requested to modify all sprinkler trailers by addition of a priming tank, which was done during the course of the program.

EVALUATION OF O&M MECHANIZATION PROGRAM IN THE PROVINCIAL IRRIGATION DEPARTMENTS

ANNEX III

Pre-Training Seminars Held With the Four PIDs

The Training Plan

An Overview of the Training Plan at Dera Murad Jamali

Pre-Training Seminars held with the Four PIDs

Seminar Held at Lahore - Punjab PID

Soon after the pilot trial was over and the equipment had been tested a seminar was arranged on August 3, 1991 in Irrigation Secretariat. In this seminar Chief Engineers, Superintending Engineers and Executive Engineers of the O&M Trial Divisions in Punjab took part. The visit to the site was also conducted and performance of the equipment was witnessed by the participants.

In this seminar, the participants were apprised of the usefulness of the O&M trial equipment and the role of the SDO's, XEN's and SE's in making the program. A success was discussed in light of the O&M workshop held during December 1990.

In this seminar, the program of employment and training the operators - in different divisions was also discussed.

Soon after the seminar was over the training of the operators of different O&M Trial Divisions was carried out after getting commitment from the Millat Tractors Ltd. and Jeco (Pvt.) Ltd. Gujranwala regarding their delivery schedule of the tractors and equipment to the different O&M trial divisions and sub-divisions.

According to the decision taken in the seminar and pursue the training program in different O&M trial Divisions, Millat Tractors Ltd. and Jeco (PVT) Ltd. was visited by the T.A. team representatives (Mr. M.A Khan and Mr. Adil Hasni) to get firm date of delivery of the equipment in Punjab.

The agreed to ensure that the tractors and the equipment would be delivered to the different Divisions as under:

Division	Tractors from Millat Delivery Dates	Jeco Implement Schedule of Delivery	Training Schedule
1. Kirana, Sargodha	24.08.91	20.08.91	25 - 29 Aug.1991
2. Multan	26.08.91	22.08.91	01 - 5 Sep. 1991
3. Bahawalpur	05.09.91	05.09.91	8 - 12 Sep. 1991

It was also ensured that the Millat people would spare their staff to train the operators during this period.

Pre-training visit was also made to Kirana, Multan and

Bahawalpur Divisions by the O&M Engineers Coordination to get the following information & transmit the same to the suppliers manufacturers.

a) Exact location of place of delivery of the tractor and the equipment.

b) The names of the persons responsible and issuance of acknowledgement.

c) The exact location where the training was to be started and selection of site.

d) Names of the operators who were to receive training and ensure that they were present on these dates.

e) Arrangement of P.O.L during training by the concerned Division.

f) Arrangement of small T&P articles needed for training.

g) Discuss any other point which could be useful for training.

After the pre-training visit, the actual training of operators was started.

The training program was then followed vigorously as the delivery of the equipments was exactly on schedule.

The training was started and completed as under:

1. Kirana Division Sargodha. Conducted at Aasianwala Rest House.

   The training was started on August 24, 1991 and completed on August, 29, 1991.

2. Multan Division Multan, started on September 01, 1991 and completed on September, 05, 1991. Conducted at Miani Rest House.

3. Bahawalpur Division Bahawalpur, started on September, 08, 1991 and completed on September, 12, 1991. Conducted at Bahawalpur Rest House.

During the training the staff of the division, especially, the SDO's and Sub Engineers was given a detailed briefing about:

a) The preparation of operation and maintenance estimates of the tractor.

b) Preparation of scheduling of the tractor and equipment with SDO's and XEN's.

c) Preparation of the work plan - to use the equipment.

d) How to keep the tractor account i.e the tractor's log book.

e) The form's 'A' 'B' and 'C' were also given to the SDO's concerned to submit the monthly progress of:

i. The tractor use. ii. The quantum of work done and iii. Utilization of different pieces of equipment.

Seminar at Karachi - Sindh PID.

A seminar was held on september 25, 1991 at Karachi under Chairmanship of the Mr. Masoud Ali Arbab Chief Engineer Sukkur in which all the three Superintending Engineers and Executive Engineers and Assistant Executive Engineers of the O&M Trial Divisions took part. The seminar was also attended by Mr. Jan P. Emert, Mr. Muzammil Hussain Qureshi from USAID, Mr. Russ Stoneman P.A Sindh, Mr. Ringenodlus, Mr George Miller, Mr. Mehboob Karim and O&M Engineer coordination (Mr. M. Aslam Khan) also attended the seminar.

There was detailed discussion about each piece of the equipment and its use. The availability of the funds for use of the equipment for O&M trial also came under discussion. It was clarified by the Chief Engineer that there would be no problem of funds and that the training program could be started and necessary arrangement for the P.O.L and other T&P articles will be made by the concerned O&M trial Divisions.

A pre_training visit to Executive Engineer of Fuleli Canal Division, Executive Engineer Hala Division and Executive Jamrao Canal Division, Mirpur Khas was made from October 07, 1991 to October 10, 1991 to discuss in detail the arrangements of training in these Divisions and take decision about:

1) P.O.L required for the tractors and equipment to be arranged by the Assistant Executive Engineers concerned to be made available at the site of training.

2) Tools required during training to be made available. Necessary instructions to be issued to the concerned person.

3) The persons who were to take training as operators, to be present on the day training was to start.

4) The assistant Executive Engineers, Sub Engineers and Daroghas to be present during the training.

5) The site where the training was to be given to the staff

of the different Divisions, was selected as under:

For Fuleli Canal Division, Matli Sub Division. For Hala Division, Tando Adam Sub Division. For Jamrao Canal Division Mirpur Khas Sub Division were selected where the training was to be started.

Before training was started, delivery of the tractors and equipment had been ensured after series of meetings with Millat Tractors Ltd. and M/S Jeco (pvt) Ltd., Gujranwala. All the tractors and equipments was delivered before the start of training in each of the Sub Divisions in Sindh.

The staff from Millat Tractors and M/S Jeco Gujranwala remained present through out the training period to impart training to the staff of these Irrigation Divisions.

The training was conducted in these selected Sub Divisions of O&M trial Divisions as under:

I. Matli Sub Division of Fuleli Canal Division, at Matli from October 13, 1991 to October 17, 1991.

II. Tando Adam Sub Division Hala Canal Division at Tando Adam from October 20, 1991 to October 24, 1991.

III. Mirpur Khas Sub Division, Jamrao Canal Division at Mirpur Khas from October 27, 1991 to October 31, 1991.

The training was completed on October 31, 1991. The staff i.e Operators, Daroghas, Sub Engineers, Assistant Executive Engineers remained present throughout the training period and showed keen interest in learning the use of the tractor and O&M equipment.

Efforts were also made to ensure that the operators practice the use of the equipment as much as possible during these five days of training.

Seminar at Peshawar - NWFP PID

A seminar was held at Peshawar on November 18, 1991. Chief Engineer Peshawar, the Superintending Engineer Southern Canal Circle Bannu, Executive Engineer Marwat Canal Division, Sub Divisional Officers of Janikhel Sub Division and Tajori Sub Division take part in the seminar.

Mr. Gene white P. Advisor NWFP, Mr. Ringanoldus C.O.P Harza and Mr. Muzammil Hussain Qureshi Chief A.R.D USAID also attended the seminar.

Mr. Mehboob Karim M&E specialist Harza, Dr. Farhat Javaid from Harza and Mr. ". A Khan O&M Engineer Coordination were present.

The use of the tractor and trial equipment for the O&M of the Canals was explained in detail by Mr. M.H Qureshi USAID and Mr. Ringenoldus C.O.P Harza.

Similarly the provision of P.O.L and other T&P required during training was agreed to by the Executive Engineer Marwat Canal Division. He also agreed to provide tractor operators for training.

A pre-training visit was also made by the O&M Engineers Coordinator Mr. M Aslam Khan on November 19,1991 to November 21, 1991 with the Executive Engineer Marwat Canal Division.

The equipment and the tractors were also checked and inspected by George Miller equipment specialist and Mr Gene White Provincial Advisor - NWFP along with Mr. Inayat Ullah Khan, Superintending Engineer Southern Canal Circle when they visited Baran Dam site on November 21, 1991. Site for training was selected near Baran Dam.

Marwat Canal Division had been selected for O&M trial, and was provided with two Sub Divisional Officers units and one Executive Engineer Unit.

During pre-training visit by O&M Engineer coordination, it was observed that:

- About 85% of the channels were in cutting and made of gravel work.
- The Marwat Canal and all the channels run only for 4 - 8 months during the year.
- Earthen banks of the channels existed only in tail reaches.
- There were very few weak reaches.
- The land by the side of the channels are mostly gravelly and the ripper and the dozer blade may not work effectively.

- The farmers whose land are lying by the side of the channels may not agree to allow - the department to borrow the soil from their land.

It was apprehended that the equipment supplied may not be used effectively. It was suggested that the equipment be given to other Division - needing continuous maintenance of Earthen channels or roads.

Training was conducted at Baran Dam site from November 23, to November 27, 1991 by the staff of Millat Tractors Ltd. and Jeco (pvt) Ltd. Gujranwala under the supervision of Mr. M. Aslam Khan O&M Engineer coordination.

After training the staff of Marwat Canal Division NWFP similar seminar was held to carryout the program in Balochistan Province.

Seminar Held at Quetta - Balochistan PID

A seminar was held at Quetta on December 09, 1991. Chief Engineer Balochistan, Superintending Engineer Pat Feeder Canal Circle Dera Murad Jamali Executive Engineer Pat Feeder Division D.M Jamali SDO, Dr. M. Jamali SDO Dera Allah Yar, SDO Hair Din Division attended the seminar.

P.A. Mr. Ringenoldus C.O.P Harza, Provincial advisor Balochistan, Mr. Mehboob Karim M&E specialist Harza, Mr. Abdul Majid Design Engineer Balochistan, Harza and Mr M.A. Khan O&M Engineer also attended the seminar.

Mr. Jan Emmert and Mr Muzammil Hussain Qureshi from USAID also attended the seminar.

The main purpose of this O&M trial program was explained to the PID staff by Mr. Ringenoldus and Muzammil Qureshi in detail. The details of the tractor operated equipment use for the maintenance of the channels was explained.

In order to meet the funding requirement Chief Engineer Balochistan assured that there was no problem of funds to use this equipment for O&M of channels and hoped that the trial would be a success.

By this time the tractors and equipment had been delivered to all the three Sub Divisions of the Pat Feeder Canal Division.

Chief Engineer Balochistan informed that since one new Sub Division has been created in this Division. This new Sub Division was Goth Tagia Sub Division with head quarter at Dera Allah Yar and be provided with an extra unit. This was agreed to by USAID and one extra unit was provided in the month of March 1992.

THE TRAINING PLAN

Day 1. Introduction to the Program.

- Inspection of the equipment.
- Notation of any damage, shortage or non compliance with procurement specification.
- Safety instruction and demonstrations.
- Tire care.
- Proper ballasting of wheels to obtain maximum traction with minimum slippage by -
  - by - water ballasting.
  - by - Wheel weights.
  - Weight attached to tractor draw bar
  - Proper inflation of tires.
  - Avoiding tire tread damage and/or excessive wear.

Day 2. Maintenance of Records.

- Log Book Maintenance.
- Daily accomplishment of log book and field production work.
- Demonstration and field operation.

Day 3. The Engine.

- Cooling System - electrical system - fuel system.
- Demonstration.
- Power train - clutch - transmission.
- Final drive
- Differential brakes - students practice.

Day 4. Operational Demonstration.

Safety, fueling, servicing of air cleaner, checking oil levels, changing of oil, greasing, Adjustments.

- Tire pressure check, operational demonstration hitching implements.

- Safety , three-point hitch implements , trailers.

Day 5. Students practice.

- Hitching, raising and lowering implements, towing trailers (forward and backing) demonstration.

- Ripping with rear mounted ripper.
- Practice and actual field operations.

Day 6. **Demonstrations.**

- Grading with the rear grader blade.
- Students practice and performing actual field operation.

Day 7. **Demonstrations.**

Safety.
Using the fronted loader and filling up the trolley with soil and off loading the same.

Day 8. **Demonstrations.**

- Safety.
- Actual field maintenance, use of equipment by the trainees.

The staff from Millat Tractors Ltd. imparted the training to the operators and remained present throughout the program.

OVERVIEW OF TRAINING AT DERA MURAD JAMALI

(The following note is a sample of training reports, prepared after initial training activities in each province.)

After the seminar at Quetta, the training to the tractor operators was completed at Dera Murad Jamali from 14 December 1991 to 18 December 1991. The training was imparted to the operators by the staff of Millat Tractors Ltd. and JECO (Pvt) Ltd. Gujranwala who also checked all the tractors and equipment supplied by them.

Tractor and Equipment Use - Training to Operators

The training to the operators was very essential as the tractors and the equipment were hydraulically operated and required special skill and practice in the use of tractor and the equipment for carrying out maintenance of the channels. The training was imparted by the staff of Millat Tractors and JECO.

I. The Tractor

The operators were given detailed lessons about the tractor, its parts and operation. Precautions to be taken before starting tractor. The cooling system, meters and control levers, brakes system (the hand brake and the foot brakes), the clutch and its use, gears system and how and when to use, the differential lock and its use, PTO shaft and how to use the same were also explained.

The hydraulic system of the tractor was also explained. They were also practically demonstrated the use of levers provided on the quadrant for operation of the equipment i.e. the draft control lever, position lever and the response control. It was also demonstrated how to use these controls when operating the tractor with the different equipment, the fuel system and the air locking and how to remove, it was also explained to them. The air cleaners, their function and the cleaning of the oil bath for the air cleaner was also explained.

The maintenance of the tractor alternator, battery, fuel tank cap, radiator cap, air filters and diesel filters, the use of hand and foot accelerators was also explained.

II. Grader Blade

Similarly the functions which could be performed by the rear grader blade for different operations were explained:

1. Dragging of earth from longer distances.

2. Levelling of the earthen roads

3. Giving proper slope to the road surface so that the rain water could flow to the outer side of the road with the help of hydraulic ram by giving the vertical tilt angle.

4. Making of ditch or water course in cutting by using the vertical tilt with the help of the hydraulic jack of the grader blade.

5. Scraping the silt with rear blade from silt heaps on the canal banks by the use of horizontal tilt angle from the rear circle plate.

6. Extending the rear blade to one side with the help of semi circular angle plate provided on the front side of the beam.

7. The horizontal tilt of the blade.

8. Precision land levelling or levelling of the roads with the help of rear rubber wheel.

9. Breaking the hard surface of the soil/road with the help of tines on the rear of the blade, after readjustment of the blade at 180 degrees and re-fixing the tines, fixed on a pipe shaft and bolted properly.

10. Using the rear blade for pushing the earth in backward direction after revolving it by 180 degree.

After having explained these functions and use of the selector valve and spool valve for the operation of the front dozer blade and rear grader blade, attaching and detaching of the hydraulic lines was explained and demonstrated to the trainees and they were asked to practice the same.

III. Front-End Loader

The operators were trained and made to practice the use of front end loader. The operators were trained in use of double spool valve levers to operate the bucket

III. Front-End Loader

The operators were trained and made to practice the use of front end loader. The operators were trained in use of double spool valve levers to operate the bucket and arm of the loader and filling the bucket and loading in to the trolley by bringing the tractor in appropriate position. The bucket of the loader has a capacity of about 1/2 cubic yard and it can lift upto 550 kgs upto a height of 10 ft.

IV. The Chisel Plow

Plowing of land with the help of chisel plough was explained to the trainees and practical use of the draft control, position control and response control was explained (while using the rear plough etc.) and demonstrated.

V. Sprinkler Trailer

The trainees were given detailed lesson on the use of sprinkler trailer especially how to fill it.

On the P.T.O shaft of the tractor, a gear box is fitted with an extended P.T.O shaft to give more revolutions with the help of a gear box which transfers the power to the shaft of the centrifugal pump to run the same at more revolutions. The fixation of the shaft of the pump with the P.T.O shaft is with the help of an axillary shaft with both ends having two universal crosses to allow the shaft to move in any direction without damaging the shaft or the pump.

This was explained to the trainees. Similarly the priming of pump with the help of bucket and filling the suction pipe and running of the pump after the suction pipe with a foot valve was inserted in to the water and simultaneous running of the pump and filling of the water was demonstrated to the trainees.

Bringing the sprinkler trailer forward and backward was also demonstrated and the trainees were made to practice the same.

Sprinkling of the road by opening the sluice valve provided on the rear pipe feeding the perforated pipe was demonstrated and explained how to use the same for watering.

VI. Tipping Trolley

It has a capacity of 110 cft. but can carry up to 130 cft. when heaped up. The soil can be off loaded at the desired place with the help of hydraulic jack installed under its body and operated by the operator through the spool of the trolley. They were also made to practice the same.

ANNEX IV

Form A
Form B
Form C
The Questionnaire

TRACTOR WORKING ACCOUNT

ISM-II, O&M EQUIPMENT TRIAL

FORM: A

PROVINCE :
CIRCLE :
DIVISION :
SUB DIVISION :

1) TRACTOR NO: :
2) DRIVER'S NAME :
3) PLACE DEPLOYED :

	JOURNEY				HOUR METER			WORK DONE						POL			SIGNATURE	
DATE	TIME	FROM	TO	DISTANCE APPR. MILES	BEFORE	AFTER	TIME WORKED (HRS)	CHANNEL	REACHES	ITEM	UNIT	QUANTY.	NAME OF THE ESTIMATE TO BE DEBITED	DIESEL	M. OIL	MISC.	DRIVER	INSPECTING OFFICER

NOTE: a) Give measurments of the works done on measurment book proforma sheet.
b) In case of earth work give leads and rate according to schedule of rate.
c) Watering and grading of road of each channel and and lengths should be given.

ISM-II EQUIPMENT TRIAL

DETAILS OF THE WORKS AND EQUIPMENT USED

FORM: B

PROVINCE :
CIRCLE :
DIVISION :
SUB-DIVISION :
DURATION :

DATE	DESCRIPTION OF CANAL SYSTEM		NATURE OF REPAIR		ESTIMATED VOLUME OF EARTH WORK (CFT)	GRADING OF ROAD TRACK (MILES)	SPRINKLING OF WATER (MILE)	TOTAL HOURS TRACTOR USED	DETAIL OF IMPLEMENT USED (HRS)					
	CANAL	REACHES *	REHABILI-TATION **	SIMPLE MAINTENANCE ***					FEL	CP	DB	GB	TT	ST

FEL = Front loader.
CP = Chisel plow
DB = Dozer blade
GB = Grader blade
TT = Tipping trolley
ST = Sprinkling trailer

* Specify the RDs.
** Where O&M equipment can not be used. this is supposedto be done under rehabilitation program.
*** Reaches or part selected for O&M equipment use.

ISM-II O&M EQUIPMENT TRIAL

IMPACT OF EQUIPMENT USE

FORM : C

NAME & TITLE OF THE EVALUATING PERSON

_____

_____

PROVINCE : _____

CIRCLE : _____

DIVISION : _____

SUB-DIVISION : _____

DURATION : _____

TRACTOR NO : _____

DESCRIPTION OF CANAL/REACH	CHANNEL BANKS						INSPECTION TRACK						REMARKS
	BEFORE			AFTER			BEFORE			AFTER			
	G	F	B	G	F	B	G	F	B	G	F	B	

G = Good F = Fair B = Bad

INSPECTION TRACK	Motorable and smooth	Motorable with minor ruts	Needs earth work for smoothening and widening at places
CHANNEL BANK	Sufficient free-board, no rain cuts, and no cattle ghats	Less freeboard, earth work needed to fill rain cuts.Few cattle ghats , no immediare threat of breaches.	Freeboard negligible, less bank width, many ghat sites, vulnerable to breaches.

QUESTIONNAIRE TO O&M TRIAL XENs, SDOs & SUB-ENGINEERs

A: Financial Aspects

i) Were adequate funds made available, from M&R funds or other source, to operate the O&M Trial equipment? Give %age of available funds a/ to total funds b/, required for full operation, @100 hrs/month/tractor.

---

ii) Time elapse from completion of training until receipt of operational funds?

---

iii) Give a comparison of the actual released funds c/ to the total funds required for full operation and to the approved work plan funds d/. Please provide %ages in each case.

---

iv) Describe the procedural constraints involved in receipt of allocated O&M trial operation funds?

---

v) How did the above stated procedural constraints affect the use of O&M trial equipment, Please describe.

---

vi) Did it cost more or less to use O&M trial equipment as compared to the normal contracting of same works?

---

vii) Were adequate funds available for repair and routine maintenance of O&M trial equipme?

NOTE: a/ : Available funds, Funds assigned from existing M&R funds or any other source for operation of O&M trial equipment.

b/ : Total funds, Funds needed to operate the O&M Trial equipment at target rate of 100 hrs/month/tractor.

c/ : Released funds, Funds physically released for operation of O&M trial equipment.

d/ : Work plan funds, Funds needed to meet the approved work plan targets.

B: Mechanical Aspects

i) List major mechanical problems encountered in operation of O&M trial equipment.

---

ii) Is tractor HP adequate for the provided implements?

---

iii) Estimate average No of months of operation between breakdowns of various implements.

---

iv) Would you recommend additional implements? Please list. How much use (hrs per month) would you anticipate for your recommended implements.

v) Are adequate repair facilities available at near by shops? Average distance of repair shops from the work place.

---

vi) List possible types of repair works which can not be done in the near by workshops. Please specify the next nearest towns where these repairs can be done and their average distances from the work place.

---

vii) Specify the source of spares used in repair works, i.e., supplier, authorized dealer or open market.

---

viii) List the vehicles received in each sub-division/division. Estimate %age use for O&M trial against total use for each vehicle.

C: Operational Issues

i) List difficulties faced by operators in physical operation of O&M trial equipment.
Were there any problems due to hydraulic control of the implements? Please describe.

---

ii) Is the operator the same who got training from Millat Tractors Ltd?

---

iii) If same tractor operator is now not working, give the reasons he left this job.

---

iv) Rate the individual implements with respect to level of difficulty of operation.

v) What are field problems in use of O&M trial package? such as space along canal/drain banks, site constraints, trees causing operational hazards. Major and minor field problems may be listed separately.

---

vi) List the advantages associated with the O&M trial equipment.

---

vii) Describe all disadvantages, if any, in use of O&M trial equipment.

D: Effectiveness

i) Rate the implements of the trial unit to perform different M&R tasks, as Poor, Fair, Good and Excellent.

ii) Did your M&R capability improved after induction of O&M trial equipment in your area?

---

iii) Is equipment also used to address emergencies like breaches or flood support duty, etc. Please describe the various general types of works performed with the equipment.

---

iv) How do you feel about use of similar implements in additional divisions of PID?

E: Departmental Issues

i) Has use of O&M trial package become a routine departmental activity?
Will it be continued after trial period?
Please describe the reasons.

---

ii) Are specific directives issued to the trial sub-divisions to utilize the M&R funds for operation of trial equipment?
Details please.

---

iii) Are work plans to use O&M trial equipment prepared and approved?
Who prepared work plans?
Who approved work plans?

iv) Are the approved work plans followed?
If,not, Why? Please provide the details.

---

v) Are progress follow up meetings conducted in SDO,s office/ XEN,s office or at any senior level?
Please provide the detail of any such meeting(s).
Please provide copies of the directives issued thereafter to address the problem(s), if any.

---

vi) Please describe the procedural constraints hampering the use of O&M trial equipment.

F: Miscellaneous Issues

i) Was there any political influence to recruit specific person?
If so, was he qualified?

---

ii) Was there any political influence to use the equipment at their desired locations?

---

iii) Was there any political pressure to misuse the equipment in their interest?

ANNEX V

Tractor Utilization Data

ISM-II
O&M EQUIPMENT TRIAL
TRACTOR UTILIZATION SUMMARY

Provinces & Divisions	SEP.91 Tractor hrs during month	OCT.91 Tractor hrs during month	NOV.91 Tractor hrs during month	DEC.91 Tractor hrs during month	JAN.92 Tractor hrs during month	FEB.92 Tractor hrs during month	MAR.92 Tractor hrs during month	APR.92 Tractor hrs during month	MAY.92 Tractor hrs during month	JUN.92 Tractor hrs during month	JUL.92 Tractor hrs during month	AUG.92 Tractor hrs during month	SEP.92 Tractor hrs during month	OCT.92 Tractor hrs during month	NOV.92 Tractor hrs during month	DEC.92 Tractor hrs during month	TOTAL Hrs EQ USED UPTO DATE	%AGE ** UTILI-ZATION UPTO DATE
PUNJAB (17 units)																		
Lahore Div.	154	142	31	0	0	87	369	178	127	81	RNA	RNA	RNA	RNA	RNA	RNA	1169	29
Kirana Div.	199	244	140	97	95	58	189	162	268	338	422	335	362	402	333	363	4007	53
Multan Div.	368	505	390	350	40	273	101	40	0	0	0	45	180	231	274	161	2958	48
Bahawalpur Div.	73	311	251	218	455	411	308	273	186	280	155	163	486	365	348	196	4479	75
PROV:TOTALS	794	1202	812	665	590	829	967	653	581	699	577	543	1028	998	955	720	12613	51
SINDH (12 units)																		
Fuleli Div.	NA	74	397	387	372	296	299	297	207	204	208	79	39	232	65	90	3246	60
Hala Div.	NA	146	133	143	217	100	150	143	145	138	136	136	135	147	117	12	1998	35
Jamrao Div.	NA	0	214	180	195	118	501	516	407	482	411	312	383	294	163		4176	75
PROV. TOTALS	NA	220	744	710	784	514	950	956	759	824	755	527	557	673	345	102	9420	57
BALOCHISTAN (5 units)																		
Jat Pat Div.	NA	NA	NA	572	147	209	225	499	357	368	412	450	230	338	259		4066	73
PROV. TOTALS	NA	NA	NA	572	147	209	225	499	357	368	412	450	230	338	259		4066	73
NWFP (4 units)																		
Southern Canal Circle.	NA	NA	NA	NA	NA	NA	NA	97	60	90	55	40	70	85	150	2	649	18
PROV. TOTALS	NA	NA	NA	NA	NA	NA	NA	97	60	90	55	40	70	85	150	2	649	18
PROJ.TOTAL	794	1422	1556	1947	1521	1552	2142	2205	1757	1981	1799	1560	1885	2094	1709	824	26748	*** 53

NA : Period not counted in analysis due to late supply of equipment or due to readjustment in equipment distribution.

RNA: Record not available.

** Percentage utilization is based on 100 hrs/month/tractor target for the No of months tractor is physically used.

*** This is the weighted average.

ISM–II
O&M EQUIPMENT TRIAL
TRACTOR UTILIZATION DETAILS

Province & Division Sub–division	SEP. 1991	OCT. 1991	NOV. 1991	DEC. 1991	JAN. 1992	FEB. 1992	MAR. 1992	APR. 1992	MAY 1992	JUN. 1992	JUL 1992	AUG. 1992	SEP. 1992	OCT. 1992	NOV. 1992	DEC. 1992	TOTAL Hrs EQPT USED UPTO DATE	% AGE UTILI-ZATION UPTO DATE **
	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month		
PUNJAB																		
Lahore Div.																		
i)XEN Lahore	78	74	20	RNA	RNA	RNA	RNA	RNA	RNA	RNA	RNA	RNA	RNA	RNA	RNA	RNA	172	57
ii)SDO Lahore	NA	NA	NA	NA	NA	NA	148	54	69	81	RNA	RNA	RNA	RNA	RNA	RNA	352	88
iii)SDO Pandoki	76	68	11	0	0	87	141	93	58	RNA	RNA	RNA	RNA	RNA	RNA	RNA	534	59
iv)SDO Changa Manga	NA	NA	NA	NA	NA	NA	80	31	RNA	RNA	RNA	RNA	RNA	RNA	RNA	RNA	111	56
DIV.TOTALS	154	142	31	0	0	87	369	178	127	81	RNA	RNA	RNA	RNA	RNA	RNA	1169	* 29
Kirana Div																		
i)XEN Kirana	0	0	0	0	0	0	0	5	17	15	24	24	22	45	66	37	255	16
ii)SDO Kirana	0	5	76	5	24	0	0	0	49	50	94	58	65	134	135	101	796	50
iii)SDO Khadir	146	186	0	0	0	0	0	40	54	111	153	90	117	95	106	181	1279	80
iv)SDO Hujjan	53	53	64	92	71	58	96	0	105	95	71	76	92	88	RNA	RNA	1014	72
v)SDO Laluwali	NA	NA	NA	NA	NA	NA	93	117	43	67	80	87	66	40	26	44	663	41
DIV.TOTALS	199	244	140	97	95	58	189	162	268	338	422	335	362	402	333	363	4007	* 53

ABBREVIATIONS:

SDO = Sub divisional officer
Div. = Division
S.E. = Suprintending engineer
NA = Not applicaole due to late supply or due to late start of trial
RNA = Record not available.

DD = Delivery Date
Prov. = Provincial
Proj. = Project

** Based upon 100 hrs per month per tractor target.
* Based upon the weighted avaerage for the entire division/province.

ISM-II
O&M EQUIPMENT TRIAL
TRACTOR UTILIZATION DETAILS

Province & Division Sub-division	SEP. 1991	OCT. 1991	NOV. 1991	DEC. 1991	JAN. 1992	FEB. 1992	MAR. 1992	APR. 1992	MAY 1992	JUN. 1992	JUL 1992	AUG. 1992	SEP. 1992	OCT. 1992	NOV. 1992	DEC. 1992	TOTAL Hrs EQPT USED UPTO DATE	% AGE UTILI-ZATION UPTO DATE **
	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month		
PUNJAB																		
Multan Div.																		
i) XEN Multan	108	125	101	62	0	100	28	5	0	0	0	0	0	33	60	0	622	39
ii)SDO Multan	104	136	103	109	40	100	34	0	0	0	0	0	27	67	118	72	910	57
iv)SDO Rashida	100	125	100	91	0	71	0	0	0	0	0	45	73	27	38	49	719	45
v) SDO Sichnai	56	119	86	88	0	2	39	35	0	0	0	0	80	104	58	40	707	44
DIV.TOTALS	368	505	390	350	40	273	101	40	0	0	0	45	180	231	274	161	2958	* 48
Bahawalpur Div.																		
i) XEN Bahawalpur	20	68	15	8	70	98	98	0	0	56	0	0	42	10	73	47	605	38
ii)SDO Bughdad ul Jadid	18	89	123	38	150	160	42	108	0	0	0	0	93	241	126	38	1226	77
iii)SDO Qaimpur	16	86	67	44	122	84	73	117	133	158	57	69	196	19	59	66	1366	85
iv)SDO Shahrwala	19	68	46	128	113	69	95	48	53	66	98	94	155	95	90	45	1282	80
DIV. TOTALS	73	311	251	218	455	411	308	273	186	280	155	163	486	365	348	196	4479	* 75
PROV:TOTALS	794	1202	812	665	590	829	967	653	581	699	577	543	1028	998	955	720	12613	* 51

ABBREVIATIONS:

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** Based upon 100 hrs per month per tractor target.
* Based upon the weighted avaerage for the entire division/province.

ISM-II
O&M EQUIPMENT TRIAL
TRACTOR UTILIZATION DETAILS

Province & Division Sub-division	SEP. 1991	OCT. 1991	NOV. 1991	DEC. 1991	JAN. 1992	FEB. 1992	MAR. 1992	APR. 1992	MAY 1992	JUN. 1992	JUL 1992	AUG. 1992	SEP. 1992	OCT. 1992	NOV. 1992	DEC. 1992	TOTAL Hrs EQPT USED UPTO DATE	% AGE UTILI-ZATION UPTO DATE **
	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month	Tractor hrs during month		
SINDH																		
Fuleli Div.																		
i) XEN Fuleli	NA	24	105	80	100	0	0	0	0	0	0	79	23	57			468	36
ii) SDO Matli	NA	24	105	104	97	92	94	102	38	59	58	0	16	44			833	64
iii)SDO Badin	NA	0	102	99	101	102	98	98	68	57	80	0	0	73	65	90	1033	69
iv)SDO Tando Bhago	NA	26	85	104	74	102	107	97	101	88	70	0	0	58			912	70
DIV. TOTALS	NA	74	397	387	372	296	299	297	207	204	208	79	39	232			3246	* 60
Hala Div.																		
i) XEN Hala	NA	35	0	0	0	0	0	0	0	0	0	0	0	20			55	4
ii) SDO Hala	NA	35	55	54	134	10	60	51	60	51	47	45	41	41	34		718	51
iii)SDO Tando Adam	NA	36	31	47	40	47	47	52	35	40	49	51	51	38			564	43
iv)SDO Shahdadpur	NA	40	47	42	43	43	43	40	50	47	40	40	43	48	83	12	661	44
DIV. TOTALS	NA	146	133	143	217	100	150	143	145	138	136	136	135	147	117	12	1998	* 36
Jamrao Div.																		
i) XEN Jamrao	NA	0	0	0	0	38	65	58	41	62	16	45	25	0			350	27
ii)SDO Mirpurkhas	NA	0	58	24	81	32	62	103	85	89	36	37	206	29			842	65
iii)SDO Jhol	NA	0	79	90	81	26	256	265	155	264	268	151	117	123	163		2038	146
iv) SDO Khadro	NA	0	77	66	33	22	118	90	126	67	91	79	35	142			946	73
DIV.TOTALS	NA	0	214	180	195	118	501	516	407	482	411	312	383	294	163		4176	* 78
PROV. TOTALS	NA	220	744	710	784	514	950	956	759	824	755	527	557	673	280		9253	* 58

ABBREVIATIONS:

SDO = Sub divisional officer
Div. = Division
S.E. = Suprintending engineer
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Proj. = Project

** Based upon 100 hrs per month per tractor target.
* Based upon the weighted avaerage for the entire division/province.

ISM–II
O&M EQUIPMENT TRIAL
TRACTOR UTILIZATION DETAILS

Province & Division Sub–division	SEP. 1991 Tractor hrs during month	OCT. 1991 Tractor hrs during month	NOV. 1991 Tractor hrs during month	DEC. 1991 Tractor hrs during month	JAN. 1992 Tractor hrs during month	FEB. 1992 Tractor hrs during month	MAR. 1992 Tractor hrs during month	APR. 1992 Tractor hrs during month	MAY 1992 Tractor hrs during month	JUN. 1992 Tractor hrs during month	JUL 1992 Tractor hrs during month	AUG. 1992 Tractor hrs during month	SEP. 1992 Tractor hrs during month	OCT. 1992 Tractor hrs during month	NOV. 1992 Tractor hrs during month	DEC. 1992 Tractor hrs during month	TOTAL Hrs EQPT USED UPTO DATE	% AGE UTILI-ZATION UPTO DATE **
BALOCHISTAN																		
Pat Feeder Div.																		
i)XEN Pat Feeder	NA	NA	NA	26	7	44	22	142	44	65	24	49	24	40	49		536	45
ii)SDO Dera Murad Jamali	NA	NA	NA	67	63	67	80	135	41	89	85	120	48	89	60		944	79
iii)SDO Hair Din	NA	NA	NA	344	39	40	12	45	73	71	76	119	17	50	47		933	78
iv)SDO Goth Tagia	NA	NA	NA	NA	NA	NA	NA	87	60	75	116	127	82	58	29		634	79
v)SDO Jhat Pat	NA	NA	NA	135	38	58	111	90	139	68	111	35	59	101	74		1019	85
PROV. TOTALS	**NA**	**NA**	**NA**	**572**	**147**	**209**	**225**	**499**	**357**	**368**	**412**	**450**	**230**	**338**	**259**		**4066**	* **73**
NWFP																		
Southern Canal Circle																		
i)SE Southern Canal Circle	NA	NA	NA	NA	NA	NA	NA	13	0	0	0	0	0	0	0	0	13	1
ii)SDO Head Works	NA	NA	NA	NA	NA	NA	NA	5	60	90	55	40	70	85	52	0	457	51
iii)SDO Sare Naurang	NA	NA	NA	NA	NA	NA	NA	15	0	0	0	0	0	0	98	2	115	13
iv)SDO Paharpur	NA	NA	NA	NA	NA	NA	NA	64	0	0	0	0	0	0	0	0	64	7
PROV. TOTALS	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**97**	**60**	**90**	**55**	**40**	**70**	**85**	**150**	**2**	**649**	* **18**
PROJ.TOTALS	**794**	**1422**	**1556**	**1947**	**1521**	**1552**	**2142**	**2205**	**1757**	**1981**	**1799**	**1560**	**1885**	**2094**	**1644**	**722**	**26581**	* **53**

ABBREVIATIONS:

SDO = Sub divisional officer
Div. = Division
S.E. = Suprintending engineer
NA = Not applicable due to late supply or due to late start of trial
DD = Delivery Date
Prov. = Provincial
Proj. = Project

** Based upon 100 hrs per month per tractor target.
* Based upon the weighted avaerage for the entire division/province.

EVALUATION OF O&M MECHANIZATION PROGRAM IN THE PROVINCIAL IRRIGATION DEPARTMENTS

ANNEX VI

Analysis of Implement Utilization Data

ISM-II
O&M EQUIPMENT TRIAL
IMPLEMENT UTILIZATION SUMMARY

Provinces & Divisions.	Total No of hrs tractor was used	NPU plus idle hrs of the tractor	Productive hrs of the tractor	XEN's & SDO's TRACTORS					
				FEL Hrs	CP Hrs	DB Hrs	GB Hrs	TT Hrs	ST Hrs
PUNJAB									
Lahore Div.	1169	462	706	0	0	365	302	0	39
Kirana Division	4007	45	3962	156	63	2112	1339	224	68
Multan Div.	2958	141	2817	252	89	1164	1121	162	29
Bahawalpur Div.	4479	311	4168	386	166	1388	1444	458	326
PROV:TOTALS	12613	959	11653	794	318	5029	4206	844	462
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				7	3	43	36	7	4
SINDH									
Fulell Div.	3246	159	3087	281	163	1349	953	158	183
Hala Div.	1998	171	1827	0	0	890	426	0	511
Jamrao Div.	4176	129	4047	179	68	944	659	1811	386
PROV:TOTALS	9420	459	8961	460	231	3183	2038	1969	1080
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				5	3	36	23	22	12
BALOCHISTAN									
Jhat Pat Div.	4066	859	3207	32	24	469	1764	214	704
PROV:TOTALS	4066	859	3207	32	24	469	1764	214	704
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				1	1	15	55	7	22
NWFP									
SE. SCC.	13	13	0	0	0	0	0	0	0
Marwat C.DIV.	457	25	432	0	0	12	0	380	40
Bannu C.Div.	115	17	98	0	0	90	8	0	0
Paharpur C.Div.	64	64	0	0	0	0	0	0	0
PROV:TOTALS	649	119	530	0	0	90	20	380	40
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				0	0	17	4	72	8
Project Totals	26748	2396	24351	1286	573	8771	8028	3407	2286
%AGE UTILIZATION OF EACH IMPLEMENT W.R.T. TOTAL USE				5	2	36	33	14	9

ABBREVIATIONS:

i) FEL =Front end loader
ii) CP =Chisel plow
iii)DB =Dozer blade
iv) NPU =Non-productive use
v) TT =Tipping trolley
vi) GB =Grader blade
vii) ST =Sprinkling trailer

ISM-II
O&M EQUIPMENT TRIAL
IMPLEMENT UTILIZATION DETAILS

Province Division Sub-division	Total tractor usage	Idle & NPU	Net usage on actual works	SE/XEN'S TRAC		SDO'S TRACTOR				REMARKS
				FEL	CP	DB	GB	TT	ST	
	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	
PUNJAB										
Lahore Div.										
i)XEN Lahore.	172	78	94	0	0	40	54	0	0	DATA SEP-NOV 1991.
ii)SDO Lahore	352	148	204	0	0	121	83	0	0	DATA MAR-JUN 1992
iii)SDO Pandoki	534	209	325	0	0	169	127	0	29	DATA SEP-91 TO MAY 92.
iv)SDO Changa Manga	111	27	83	0	0	35	38	0	10	Partial data up to JUNE
DIV.TOTALS	1169	462	706	0	0	365	302	0	39	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				0	0	52	43	0	6	Percentage is based on the net usage
Kirana Div										
i)XEN Kirana	255	17	238	156	48	0	34	0	0	DATA SEP 91 TO DEC 92.
I)SDO Kirana	796	10	786	0	15	630	141	0	0	DATA SEP 91 TO DEC 92.
ii)SDO Khadir	1279	12	1267	0	0	678	589	0	0	DATA SEP 91 TO DEC 92.
iii)SDO Hujjan	1014	2	1012	0	0	359	371	214	68	DATA SEP 91 TO DEC 92.
iv)SDO Laluwali	663	4	659	0	0	445	204	10	0	DATA MAR 92 TO DEC 92.
DIV.TOTALS	4007	45	3962	156	63	2112	1339	224	68	DATA SEP 91 TO DEC 92.
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				4	2	53	34	6	2	Percentage is based on the net usage

ABBREVIATIONS:

SDO = Sub divisional officer
Div. = Division
C. = Canal
NPU = Non productive use
IR. = Idle Running.
S.E. = Suprintending engineer

ISM-II
O&M EQUIPMENT TRIAL
IMPLEMENT UTILIZATION DETAILS

Province Division Sub-division	Total tractor usage	Idle & NPU	Net usage on actual works	SE/XEN'S TRAC		SDO'S TRACTOR				REMARKS
				FEL	CP	DB	GB	TT	ST	
	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	
PUNJAB										
Multan Div.										
i) XEN Multan	622	49	573	221	89	0	263	0	0	DATA SEP 91 TO DEC 92.
ii)SDO Multan	910	38	872	0	0	520	271	56	25	DATA SEP 91 TO DEC 92.
iv)SDO Rashida	719	24	695	31		266	319	75	4	DATA SEP 91 TO DEC 92.
v) SDO Sidhnai	707	30	677	0	0	378	268	31	0	DATA SEP 91 TO DEC 92.
DIV.TOTALS	2958	141	2817	252	89	1164	1121	162	29	DATA SEP 91 TO DEC 92.
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				9	3	41	40	6	1	Percentage is based on the net usage
Bahawalpur Div.										
i) XEN Bahawalpur	605	53	552	386	166	0	0	0	0	DATA SEP 91 TO DEC 92.
ii) SDO Bughdadul Jadid	1226	30	1196	0	0	445	479	154	118	DATA SEP 91 TO DEC 92.
iii)SDO Qaimpor	1366	135	1231	0	0	445	608	90	88	DATA SEP 91 TO DEC 92.
iv)SDO Shahiwala	1282	93	1189	0	0	498	357	214	120	DATA SEP 91 TO DEC 92.
DIV. TOTALS	4479	311	4168	386	166	1388	1444	458	326	DATA SEP 91 TO DEC 92.
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				9	4	33	35	11	8	Percentage is based on the net usage
PROV:TOTALS	12613	959	11653	794	318	5029	4206	844	462	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				7	3	43	36	7	4	

ABBREVIATIONS:

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ISM-II
O&M EQUIPMENT TRIAL
IMPLEMENT UTILIZATION DETAILS

Province Division Sub-division	Total tractor usage	Idle & NPU	Net usage on actual works	SE/XEN'S TRAC.		SDO'S TRACTOR				REMARKS
				FEL	CP	DB	GB	TT	ST	
	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	
SINDH										
Fuleli Div.										
i) XEN Fuleli	468	24	444	101	58	THE 105,80 & 100 HRS				DATA WITH SDOS MATLI, T.BHAGO & BADIN.
ii) SDO Matli	833	31	802	70	35	340	269	69	124	
iii)SDO Badin	1033	4	1029	60	40	617	365	40	7	
iv)SDO T.Bhago	912	100	812	50	20	392	319	49	52	
DIV. TOTALS	3246	159	3087	281	163	1349	953	158	183	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				9	5	44	31	5	6	
Hala Div.										
i) XEN Hala	55	55	0	0	0	0	0	0	0	Parked,no use
ii) SDO Hala	718	40	678	0	0	428	111	0	139	
iii)SDO T.Adam	564	36	528	0	0	230	160	0	138	
iv)SDO Shahdadpur	661	40	621	0	0	232	155	0	234	
DIV. TOTALS	1998	171	1827	0	0	890	426	0	511	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				0	0	50	24	0	29	
Jamrao Div.										
i) XEN Jamrao	350	45	305	179	68	0	37	0	21	WORKED WITH SDO,S IMP.
ii)SDO Mirpurkhas	842	58	784	0	0	165	139	245	235	
iii)SDO Jhol	2038	5	2033	0	0	365	92	1454	122	DATA IS NOT RELIABLE
iv) SDO Khadro	946	21	925	0	0	414	391	112	8	
DIV.TOTALS	4176	129	4047	179	68	944	659	1811	386	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				4	2	23	16	45	10	
PROV. TOTALS	9420	459	8961	460	231	3183	2038	1969	1080	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				5	3	35	22	22	12	

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ISM-II
O&M EQUIPMENT TRIAL
IMPLEMENT UTILIZATION DETAILS

Province Division Sub-division	Total tractor usage	Idle & NPU	Net usage on actual works	SE/XEN'S TRAC.		SDO'S TRACTOR				REMARKS
				FEL	CP	DB	GB	TT	ST	
	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	Hrs	
BALOCHISTAN										
Pat Feeder Div.										
i)XEN Pat Feeder	536	15	521	32	24	0	465	0	0	work with SDO,s imp.
ii)SDO Dera Murad Jama	944	36	908	0	0	138	413	8	349	
iii)SDO Hair Din	933	485	448	0	0	114	272	48	14	
iv)SDO Goth Tagia	634	202	432	0	0	18	258	115	41	
v)SDO Jhat Pat	1019	121	898	0	0	199	356	43	300	
PROV. TOTALS	4066	859	3207	32	24	469	1764	214	704	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				1	1	15	55	7	22	
NWFP										
Southeren Canal Circle										
i)SE SCC Bannu	13	13	0	0	0	0	0	0	0	
ii)SDO Head Works	457	25	432	0	0	0	12	380	40	
iii)SDO Sare Naurang.	115	17	98	0	0	90	8	0	0	
iv)SDO Pahar Pur	64	64	0	0	0	0	0	0	0	
PROV. TOTALS	649	119	530	0	0	90	20	380	40	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				0	0	17	4	72	8	
PROJ.TOTALS	26748	2396	24351	1286	573	8771	8028	3407	2286	
PERCENTAGE USE OF EACH IMPLEMENT AS COMPARED TO TOTAL PRODUCTIVE USAGE				5	2	36	33	14	9	

ABBREVIATIONS:

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S.E. = Suprintending engineer

EVALUATION OF O&M MECHANIZATION PROGRAM IN THE PROVINCIAL IRRIGATION DEPARTMENTS

ANNEX VII

Hourly Cost Calculations

ISM-II/O&M TRIAL

ANALYSIS FOR HOURLY UTLIZATION COST OF O&M TRIAL EQUIPMENT

I	II	III	IV	V	VI	VII	VIII	IX	X
EQUIPMENT	PRICE Rs.	STANDARD LIFE IN YEARS	STANDARD LIFE IN HOURS	ANNUAL PROJECTED USE IN HOURS	ACTUAL LIFE IN YEARS *	CAPITAL RECOVERY FACTOR **	ANNUAL CAPITAL RECOV.@ 10% INT. &10% SLVG VALUE ***	MAINT. COST PER YEAR @5% .05(II)	TOTAL ANNUAL COST (VIII+IX)
STANDARD UNIT									
TRACTOR	208400	15	10000	1200	8.33	0.18250	34229.70	10420.00	44649.70
FRONT DOZER	17000	10	5000	444	10	0.16275	2490.08	850.00	3340.08
REAR GRADER	20800	10	5000	408	10	0.16275	3046.68	1040.00	4086.68
TIPPING TROLLEY	48900	10	10000	180	10	0.16275	7162.63	2445.00	9607.63
SPRINKLING TRIALOR	151000	10	10000	120	10	0.16275	22117.73	7550.00	29667.73
CHISEL PLOUGH	11315	10	10000	48	10	0.16275	1657.36	565.75	2223.11

Column Total		=	93574.92
HOURLY CAPITAL COST OF THE EQUIPMENT	((93574.92/1200)	=	Rs. 77.98/hr
PER HOUR OPERATIONAL COST OF THE TRIAL TRACTOR	(B)	=	Rs. 70.89/hr
TOTAL OPERATIONAL COST	(A+B)	=	Rs.148.87/hr
Say		=	Rs.150.00/hr

NOTE:

PLEASE REFER TO THE ATTACHED CALCULATIONS FOR OPERATIONAL COST= RS. 70.89/HOUR

* NUMBER OF YEARS IN WHICH HOURLY OR RECOMMENDED LIFE IN WORKING YEARS, WHICH EVER IS LESS, WILL BE CONSUMED.

** FACTOR FROM STANDARD COMPOUND INTEREST TABLES.

*** AT THIS RATE ALL CAPITAL COSTS INCLUDING 10% INTEREST WILL BE RECOVERED IN WORKING LIFE OF THE EQUIPMENT.

ESTIMATE FOR THE OPERATION AND MAINTENANCE OF A TRACTOR FOR ONE YEAR.

Direct charges

I. Pay of the Driver/Tractor Operator specially trained for the use of special equipment. = 12 Months

II. POL required for operation:

(a) Diesel required for operation of the tractor @ 5.0 liters per hour of tractor working for 1200 hours per year = 6000 Liters

(b) Change of engine oil (capacity of the sump=6.8 liters say 7 liters) and engine oil to be changed at 30 hours and then at every 100 hours i.e., for 13 times quantity of engine oil: 7x13 = 91 Liters

(c) Transmission and hydraulic oil change, gear box, capacity 32.9 say 33 liters.
change at 30 hours
530 "
1030 "
1530 " (4 times x 33) = 132 Liters

(d) Topping of engine oil, 1 liter between changes i.e. 12 times = 12 liters

(e) Topping of transmission oil @ two liters per 100 hours, for 1200 hours = 24 liters

(f) Oil required for changeling the air filter bath @ 1/2 liters per week 12x 4x1/2, total engine oil = 24 liters

(g) Grease required for nipples of the tractor and equipment 1 Ib.per week 12x4 Ibs. = 48

III. Change of Maintenance Parts:

(a) Primary filters every 100 hrs i.e. 30, 130,230,330,430,530,630,730,730,830,930, 1030, = 13 Nos.

(b) Change of secondary fuel filters. These are to be changed after every 200 hours i.e. 30, 230, 430, 630, 830, 1030 and 1230 hours. = 7 Nos.

IV. Checking at the workshop of authorized dealers:

(a)	Checking of tappets at 1030 hours and 1230 hours	=	2 times
(b)	Injector service: at 530 hours is free at 1030 hours to be paid	=	1 time
(c)	Check of transmission system at 1030 hours at 1560 hours (checking at 30 hours & 530 hours is free).	=	2 times
(d)	Checking of front wheel hub at 830, 1030 & 1230 hours (checking at 30 hours. 230 hours and 630 hours is free)	=	3 times
(e)	Check of P.T.O.clutch free until 630 hours and to be checked after 100 hours interval until 1230 hours.	=	6 times

V. Repair and Readjustment of Parts:

(a)	Change of battery after 12 months	=	1 No.
(b)	Change of fan belt etc.	=	1 No.
(c)	Repair to tires etc.@ 100/P.M.	=	L.S.
(d)	Replacement of worn out nuts and bolts	=	L.S.
(e)	Replacement of linking pins and other minor parts.	=	L.S.

VI. Procurement of tools etc. for each Tractor in addition to what is supplied by the suppliers:

(a)	15 ton hydraulic jack	=	1 No.
(b)	Complete set of ring spanners	=	1 set
(c)	Screw driver	=	1 No.
(d)	Screw wrench adjustable 10" & 12"	=	1 No.
(e)	Funnel.	=	1 No.
(f)	Oil measuring can	=	1 No.
(g)	Lever action hand operated grease gun	=	1 No.
(h)	Pump type hand operated oil can	=	1 No.
(i)	Tire pressure gauge	=	1 No.
(j)	Long chain 15x3/8" with eye and pull hooks	=	1 No.
(k)	Fuel can 5 gallons	=	2 No.
(l)	Gate valve for oil barrel use	=	1 No.
(m)	Oil barrel for storing diesel	=	1 No.
(n)	Trunk for storing of smaller items to keep them dust free	=	1 No.
(o)	Wheel barrows for use by beldars.	=	1 No.
(p)	Rags	=	30 KG.

Direct Cost		Rupees
I.	Salary of the tractor operator for 12 months @ Rs. 1500/P.M.	= 18,000
II.	**POL**	
(a)	Diesel consumption 6000 liters @ Rs. 5.10/liter	= 30,600
(b)	Engine oil (b+c+d+e+f) (91+132+12+24+24)=283 liter @ 35.10/ lit	= 9,933
(c)	Grease requires 48 lbs.@ Rs. 50/lb.	= 2,400
III.	**Change of maintenance parts:**	
(a)	Primary fuel filter-13 Nos@ 150/each	= 1,950
(b)	Secondary fuel filters 7 Nos. @ Rs. 200/each.	= 1,400
IV.	**Checking at workshop:**	
(a)	Checking of tappets 2 times @ 150/-	= 300
(b)	Injector service 1 time @1200/-	= 1,200
(c)	Checking transmission services 2 times @ 500/-	= 1,000
(d)	Checking of front wheel hub 3 times @200/	= 600
(e)	Check of clutch adjustment 6 times @ Rs. 150/-	= 900
V.	**Repair & Replacement of Parts:**	
(a)	Change of Battery 1 No.@ 1500/-	= 1,500
(b)	Change of fan belt 1 No. @ 50/-	= 50
(c)	Repair to tire @ Rs.60/- P.M.	= 720
(d)	Replacement of worn out parts & nuts and bolts, L.S.	= 500
(e)	Change and replacement of locking pins and other parts, L.S.	= 400
	TOTAL (I to V)	**= 71453**
VI.	**Procurement of tools etc. for tractor:**	
(a)	15 ton hydraulic jack @ 500/each	= 500
(b)	Complete set of ring spanners @ 500/each	= 500
(c)	Screw drivers 2 Nos. @ Rs. 30/each	= 60
(d)	Screw wrench 10"x12" 2 Nos.@ 120/each	= 240
(e)	Funnel one No. @ Rs.20/each	= 20
(f)	Oil measuring can 1 No. @ Rs.50/-	= 50
(g)	Lever action hand operated grease gun @ Rs.150/-	= 150

(h)	Pump type hand operated oil can 1 No. @Rs. 50/each	=	50
(i)	Tire pressure gauge 0-50 lbs ,1 No @ Rs.100	=	100
(j)	Log chain 15'X3/8" with hook and eye pull hook 1 No @Rs. 350/each.	=	350
(k)	Fuel cans 5 gallons 2 No @ Rs. 200/each	=	400
(l)	One No oil barrel @ Rs. 450/each	=	450
(m)	One gate valve for oil barrel @Rs 100/each	=	100
(n)	Trunk for storing of small items and to keep them dust proof 1 No @ Rs. 150/each	=	150
(o)	Wheel barrows 4 No @ Rs. 1000/each	=	4000
(p)	Rags 30 Kg @ Rs. 15/Kg	=	450
	TOTAL (VI)		**7570**
VII.	**Registration and Insurance charges**	**=**	**2000**
	TOTAL AMOUNT (I to VII)	**=**	**81023**
VIII.	**Contingencies @ 5%**	**=**	**4051**
	TOTAL COST FOR ONE YEAR OPERATION (Equivalent to 1200 hrs use)	**=**	**85074**
	PER HOUR OPERATING RATE (85074/1200)	**=**	**70.89**
	Say Rs.	=	75.00

EVALUATION OF O&M MECHANIZATION PROGRAM IN THE PROVINCIAL IRRIGATION DEPARTMENTS

ANNEX VIII

Comparative Cost Analysis

ISM-11
O&M EQUIPMENT TRIAL
COST ANALYSIS SUMMARY

Province, Division & Sub-division	Total No of hrs tractor used Hrs	Hourly rate of equip. Rs/Hr	Cost of equipment use Rs	Description of works performed and units: Earth work & its supply incl. 100 ft lead		Earth work supply incl. lead in excess of 100 ft.		Grading levelling and prep. of earth. roads 10 ft wide		Silt clearance from canal beds		Sprinkling of water on canal and drain inspection tracks		Rehandling of earth, lead up to 50 ft.		Transport of material		Total cost if contract-ing of same work on schedule rate is done
				Quant. (1000 cft)	Cost Rs.	Quant. (1000 cft)	Cost Rs.	Quant. Equv. 1000sft	Cost Rs.	Quan (1000 cft)	Cost Rs.	Quant. Equv. 1000sft	Cost Rs.	Quant. (1000 cft)	Cost Rs.	Quant 100 cft	Cost Rs.	
PUNJAB																		
Lahore Div.	1169	150	175350	58	11340	77	16194	2150	96255	0	0	1410	5640	0	0	0	0	129429
Kirana Div.	4007	150	601050	730	143020	436	165925	4555	184452	150	12584	3215	16075	0	0	0	0	522056
Multan Div.	2958	150	443700	210	41208	672	177144	1590	71184	0	0	490	1960	0	0	0	0	291496
Bahawalpur Div.	4479	150	671850	383	75106	145	60419	16895	756389	442	77700	9224	46120	0	0	26	3900	1019634
Prov. Totals	*12613*	150	*1891950*	*1382*	*270674*	*1330*	*419682*	*25190*	*1108280*	*592*	*90284*	*14339*	*69795*	*0*	*0*	*26*	*3900*	*1962615*
PERCENTAGE OF TOTAL COST					*14*		*21*		*56*		*5*		*4*		*0*		*0*	CIV/TR=1.04
SINDH																		
Fuleli Div.	3246	150	486900	502	127619	111	81949	6842	362626	0	0	6065	30325	0	0	0	0	602519
Hala Div.	1998	150	299700	266	67489	160	43926	18455	978115	46	9616	39235	196175	4	508	0	0	1295829
Jamrao Div.	4176	150	626400	84	21395	627	286178	3640	192920	0	0	9656	48280	349	44277	100	11877	604927
Prov. Totals	*9420*	150	*1413000*	*852*	*215503*	*898*	*412053*	*28937*	*1533661*	*46*	*9616*	*54956*	*274780*	*353*	*44785*	*100*	*11877*	*2503275*
PERCENTAGE OF TOTAL COST					*9*		*16*		*61*		*0*		*11*		*2*		*0*	CIV/TR=1.77
BALOCHISTAN																		
Jat Pat Div.	4066	150	609900	69	40503	62	74828	30429	1859283	0	0	27645	138225	0	0	0	0	2112839
Prov. Totals	*4066*	150	*609900*	*69*	*40503*	*62*	*74828*	*30429*	*1859283*	*0*	*0*	*27645*	*138225*	*0*	*0*	*0*	*0*	*2112839*
PERCENTAGE OF TOTAL COST					2		4		88		0		7		0		0	CIV/TR=3.46
NWFP																		
Three Divs.	649	150	97350	0	0	119	48325	618	27668	0	0	150	600	0	0	0	0	76593
Prov. Totals	*649*	150	*97350*	*0*	*0*	*119*	*48325*	*618*	*27668*	*0*	*0*	*150*	*600*	*0*	*0*	*0*	*0*	*76593*
PERCENTAGE OF TOTAL COST					*0*		*100*		*0*		*0*		*0*		*0*		*0*	CIV/TR=0.79
Project Total	*26748*	150	*4012200*	*2303*	*527680*	*2409*	*954888*	*85174*	*4528892*	*638*	*99900*	*97090*	*483400*	*353*	*44785*	*126*	*15777*	*6655322*
PERCENTAGE OF TOTAL COST					*8*		*14*		*68*		*2*		*7*		*1*		*0*	CIV/TR=1.67

Note : CIV/TR = Cost of civil works/cost of tractor use to do these works.

ISM–II
O&M EQUIPMENT TRIAL
COST ANALYSIS

Province / Division & Sub-division	Total No of hrs tractor was used	Hourly rate of equip. use	*** Cost of equip. use	Earth work & its supply incl 100 ft. lead 1000 cft		Earth work supply incl. lead in excess of 100 ft. 1000 cft		Grading levelling and prep. of earth surfaces. 1000 sft		Silt clearance from canal beds 1000 cft		Sprinkling water on tracks 1000 ft @ 1000sft		Rehandling of earth, load upto 50 ft 1000 cft		Transport of material 100 cft		** Total cost if contracting of same work if done on scheduled rates	REMARKS
				RATES IN RUPEES WITH APPLICABLE PREMIUM *															
				P 195.90		P = See Schedule		P = Rs.44.77		P See Schedule		P = 5.0		S 127.05,earth		P = NA			
				S 254.10		S = See Schedule		S = Rs.53.00		S = See Schedule		S = 5.0		N = 101.50, earth		S = See Schedule			
				N		N =		N =		N		N = 5.0		N = 290.50, shingle		N =			
PUNJAB				B = 587.25		B = See Schedule		B = Rs.74.70		B NA		B = 5.0		B = 139.00		B = See Schedule			
LAHORE DIV.	Hrs	Rs/Hr	Rs	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant	Cost Rs.		
i)XEN Lahore	172	150.00	25800	0.00	0	24.59	5236	0	0	0.00	0	0	0	0.00	0	0.00	0	5236	EW 24.59,LEAD 200 FT.
ii)SDO Pandoki	534	150.00	80100	49.73	9742	13.80	2821	500	22385	0.00	0	210	840	0.00	0	0.00	0	35788	EW 13.8, LEAD 150 FT.
						4.95	1054											1054	EW 4.95,LEAD= 200 FT
iii)SDO Lahore	352	150.00	52800	0.00	0	33.27	7083	0	0	0.00	0	0	0	0.00	0	0.00	0	7083	EW 33.27, LEAD = 200 FT.
iv)SDO Chunga Manga	111	150.00	16650	8.16	1598	0.00	0	1650	73870	0.00	0	1200	4800	0.00	0	0.00	0	80268	
DIV.TOTALS	1169	150.00	175350	57.89	11340	76.61	16194	2150	96255	0.00	0	1410	5640	0.00	0	0.00	0	129429	WORKS COST/TRAC.USE COST= 0.74
DIVISION WISE %AGES OF WORK'S COST TO TOTAL COST OF WORKS IN THE DIVISION					9		13		74		0		4		0		0	100	
Kirana Div																			
i)XEN Kirana	255	150.00	38250	35.90	7034	36.34	7738	4300	192511									207283	EW 36.34, LEAD =200 FT.
ii)SDO Kirana	796	150.00	119400	87.00	17045	68.70	14629	720	32234									63908	EW 68.7, LEAD =200 FT.
						62.30	13796											13796	EW 62.3, LEAD=250 FT.
iii)SDO Khadir	1279	150.00	191850	442.96	86785	98.85	21049	0	0	0.00	0	0	0	0.00	0	0.00	0	107834	EW 98.85, LEAD=200 FT.
						41.30	9146											9146	EW 41.3, LEAD=250 FT.
iv) SDO Hujan	1014	150.00	152100	200.03	39190	22.57	6151	3835	152218	150.00	12584	3215	16075	0.00	0	0.00	0	226217	EW 22.57, LEAD=550 FT.
						20.69	69469											69469	EW 20.69,LEAD=1050 FT
						16.80	7664											7664	EW 16.8 ,LEAD=1910 FT
v)SDO Lalwali	663	150.00	99450	Works detail unavail.		104.46	24021	0	0	0.00	0	0	0	0.00	0	0.00	0	24021	EW 104.46, LEAD 300 FT.
DIV.TOTALS	4007	150.00	601050	729.99	143020	435.67	165925	4555	184452	150.00	12584	3215	16075	0.00	0	0.00	0	522056	WORKS COST/TRAC.USE COST= 0.87
DIVISION WISE %AGES OF WORK'S COST TO TOTAL COST OF WORKS IN THE DIVISION					27		32		35		2		3		0		0	100	

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ISM–II
O&M EQUIPMENT TRIAL
COST ANALYSIS

Province

Division & Sub-division

PUNJAB

	Total No of hrs tractor was used	Hourly rate of equip. use	*** Cost of equip. use	Earth work & its supply incl. 100 ft. load 1000 cft		Earth work supply incl. load in excess of 100 ft. 1000 cft		Grading levelling and prep. of earth surfaces. 1000 sft		Silt clearance from canal beds 1000 cft		Sprinkling water on tracks 1000 @ 1000sft		Rebundling of earth, load upto 50 ft 1000 cft		Transport of material 100 cft		** Total cost if contracting of same work if done on scheduled rates	REMARKS
				RATES IN RUPEES WITH APPLICABLE PREMIUM *															
				P	195.90	P =See Schedule		P =	Rs.44.77	P See Schedule		P - 5.0		S = 127.05,earth		P =	NA		
				S	254.10	S =See Schedule		S =	Rs.53.00	S =See Schedule		S 5.0		N =101.50, earth		S =See Schedule			
				N		N =		N =		N =		N - 5.0		N =290.50, shingle		N =			
				B	587.25	B =See Schedule		B =	Rs.74.70	B	NA	B - 5.0		B =139.00		B =See Schedule			
MULTAN DIV.	Hrs	Rs/Hr	Rs	Quant	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs	Quant	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant	Cost Rs.		
i) XEN Multan	522	150.00	93300	works accomplished		are shown	with SDO	Multan & SDO Rashida Units			0	0	0	0	0	0	0	0	
ii)SDO Multan	910	150.00	136500	73.81	14459	5.36	1141	490	21937	0.00	0	490	1960	0.00	0	0.00	0	39498	EW 5.36, LEAD 200 FT.
						310.40	71380											71380	EW 310.4, LEAD 300 FT.
						41.20	21410											21410	EW 41.2, LEAD 0.5 MILE.
						1.50	1323											1323	EW 1.5, LEAD 2.0 MILE.
						1.96	1892											1892	EW 1.96, LEAD 2.6 MILE.
						3.15	3362											3362	EW 3.15, LEAD 3.2 MILE.
						2.51	2679											2679	EW 2.51, LEAD 3.5 MILE.
						1.75	1738											1738	EW 1.75, LEAD 3.0 MILE.
iv)SDO Rashida	719	150.00	107850	30.90	6054	3.90	797	1100	49247	0.00	0	0	0	0.00	0	0.00	0	56098	EW 3.9,LEAD 150 FT.
						15.20	3237											3237	EW 15.2,LEAD 200 FT.
						12.70	2812											2812	EW 12.7,LEAD 250 FT.
						c7.90	15614											15614	EW 67.9,LEAD 300 FT.
						27.45	6785											6785	EW 27.45,LEAD 400 FT
						2.20	541											541	EW 2.2,LEAD 500 FT.
						1.50	409											409	EW 1.5,LEAD 550 FT.
						21.15	7023											7023	EW 21.15,LEAD 900 FT.
						3.30	1040											1040	EW 3.3,LEAD 800 FT.
						2.33	655											655	EW 2.33,LEAD 600 FT.
v) SDO Sidhnai	707	150.00	106050	105.63	20695	119.55	27492	0	0	0.00	0	0	0	0.00	0	0.00	0	48187	EW 119.55, LEAD=300 FT.
						27.30	5813											5813	EW 27.3, LEAD=200 FT.
						3.00	116											116	EW 3.0, LEAD=1000 FT.
						5.00	4966											4966	EW 5.0, LEAD=3.0 MILE.
DIV.TOTALS	2958	150.00	443700	210.34	41208	672.31	177144	1590	71184	0.00	0	490	1960	0.00	0	0.00	0	291497	WORKS COST/TRAC.USE COST= 0.66
DIVISION WISE %AGES OF WORK'S COST TO TOTAL COST OF WORKS IN THE DIVISION					14		61		24		0		1		0		0	100	

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ISM-II
O&M EQUIPMENT TRIAL
COST ANALYSIS

Province / Division & Sub-division	Total No of hrs tractor was used	Hourly rate of equip. use	*** Cost of equip. use	Description of works performed and units: Earth work & its supply incl. 100 ft. lead 1000 cft		Earth work supply incl. lead in excess of 100 f. 1000 cft		Grading levelling and prep. of earth. surfaces. 1000 sft		Silt clearance from canal beds 1000 cft		Sprinkling water on tracks 1000ft @ 1000sft		Rehandling of earth, lead upto 50 ft 1000 cft		Transport of material 100 cft		** Total cost if contracting of same work if done on scheduled rates	REMARKS
				RATES IN RUPEES WITH APPLICABLE PREMIUM *															
				P = 195.90		P = See Schedule		P = Rs.44.77		P = See Schedule		P = 5.0		S = 127.05, earth		P = NA			
				S = 254.10		S = See Schedule		S = Rs.53.00		S = See Schedule		S = 5.0		N = 101.50, earth		S = See Schedule			
				N =		N =		N =		N =		N = 5.0		N = 290.50, shingle		N =			
PUNJAB				B = 587.25		B = See Schedule		B = Rs.74.70		B = NA		B = 5.0		B = 139.00		B = See Schedule			
BAHAWALPUR DIV.	Hrs	Rs/Hr	Rs	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant	Cost Rs.		
i) XEN Bahawalpur	605	150.00	90750	Works details i/c in SDOs works.			0	0	0	0	0	0	0	0	0	0	0	0	
ii)SDO Bughladul Jadi	1226	150.00	183900	0.00	0	5.10	4783	2058	92137	130.00	24435	1196	5980	0.00	0	0.00	0	127334	EW 5.1, LEAD = 2.50 MILE
						0.96	900											900	EW 0.96, LEAD=2.0 MILE
iii)SDO Qaimpur	1366	150.00	204900	21.83	4271	36.50	7772	11585	518660	145.00	24786	4415	22075	0.00	0	0.00	0	577565	EW 36.5, LEAD=200 FT.
						6.52	5752											5752	EW 6.52, LEAD= 2.0 MILE
						14.00	15719											15719	EW 14,LEAD=4.0 MILE.
						17.00	7230											7230	EW 17, LEAD= 2000 FT
						13.00	6347											6347	EW 13.0, LEAD= 1500 FT
iv)SDO Shahwala	1242	150.00	192300	361.66	70835	16.50	4356	3252	145592	166.60	28479	3613	18065	0.00	0	26.00	3900	271227	EW 16.5, LEAD= 500 FT
						35.50	7559											7559	EW 35.5, LEAD= 200 FT.
						2.00	1543											1543	EW 2.0, LEAD= 5000 FT.
						40.95	36129											36129	EW 40.95, LEAD= 2.0 MILE.
						16.10	18077											18077	EW 16.1, LEAD= 4.0 MILE.
DIV. TOTALS	4479	150.00	671850	383.46	75106	145.08	60419	16895	756389	441.60	77700	9224	46120	0.00	0	26.00	3900	1019634	WORKS COST/TRAC.USE COST= 1.54
DIVISION WISE %AGES OF WORK'S COST TO TOTAL COST OF WORKS IN THE DIVISION					7		6		74		8		5		0		0	100	
PROV:TOTALS	12613	150.00	1891950	1381.68	270674	1329.67	419682	25190	1108281	591.60	90284	14339	69795	0.00	0	26.00	3900	1962616	WORKS COST/TRAC.USE COST= 1.04
PROVINCE WISE %AGE OF WORK'S COST TO TOTAL COST					14		21		56		5		4		0		0	100	

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ISM-II
O&M EQUIPMENT TRIAL
COST ANALYSIS

Province / Division & Sub-division / SINDH	Total No of hrs tractor was used	Hourly rate of equip use	*** Cost of equip. use	Description of works performed and units: Earth work & its supply incl. 100 ft. load 1000 cft		Earth work supply incl. lead in excess of 100 ft. 1000 cft		Grading levelling and prep. of earth. surfaces. 1000 sft		Silt clearance from canal beds 1000 cft		Sprinkling water on tracks 1000 ft @ 1000sft		Rehandling of earth, load upto 50 ft 1000 cft		Transport of material 100 cft		** Total cost if contracting of same work if done on scheduled rates	REMARKS
				RATES IN RUPEES WITH APPLICABLE PREMIUM *															
				P = 195.90		P =See Schedule		P = Rs.44.77		P =See Schedule		P = 5.0		S =127.05,earth		P = NA			
				S = 254.10		S =See Schedule		S = Rs.53.00		S =See Schedule		S = 5.0		N =101.50, earth		S =See Schedule			
				N =		N =		N =		N =		N = 5.0		N =290.50, shingle		N =			
				B = 587.25		B =See Schedule		B = Rs.74.70		B = NA		B = 5.0		B =139.00		B =See Schedule			
FULELI DIV.	Hrs	Rs/Hr	Rs	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs.	Quant	Cost Rs.		
i) XEN Fuleli	468	150.00	70200	41.78	10616	Works performed in 468 hrs are included in the SDO,s works given below.									0	0	0	10616	
ii) SDO Mati	833	150.00	124950	62.43	15863	19.20	5328	5472	290016	0.00	0	5095	25475	0.00	0	0.00	0	336682	EW 19.2, LEAD=200 FT.
						35.00	24455											24455	EW 35.0, LEAD=2000 FT.
iii)SDO Badin	1033	150.00	154950	215.95	54873	28.87	26482	800	42400	0.00	0	400	2000	0.00	0	0.00	0	125755	EW 28.87, LEAD=1.0 MILE
iv)SDO Tando Bhago	912	150.00	136800	182.08	46267	28.00	25684	570	30210	0.00	0	570	2850	0.00	0	0.00	0	105011	EW 28.0, LEAD=ONE MILE.
DIV. TOTALS	3246	150.00	486900	502.24	127615	111.07	81949	6842	362626	0.00	0	6065	30325	0.00	0	0.00	0	602520	WORKS COST/TRAC.USE COST= 1.24
DIVISION WISE %AGES OF WORK'S COST TO TOTAL COST OF WORKS IN THE DIVISION					21		14		60		0		5		0		0	100	
Hala Div.																			
i) XEN Hala	55	150.00	8250	0.00	0	0.00	0	0	0	0.00	0	0	0	0.00	0	0.00	0	0	NO PRODUCTIVE WORK.
ii) SDO Hala	718	150.00	107700	166.00	42181	66.00	18315	1180	62540	20.50	4333	2585	12925	0.00	0	0.00	0	140293	EW=66.0, LEAD 200 FT.
iii)SDO Tando Adam	564	150.00	84600	12.60	3202	47.60	12652	13350	707550	0.00	0	12800	64000	0.00	0	0.00	0	787404	EW=47.6, LEAD 150 FT.
						3.20	888											888	EW=3.2, LEAD 200 FT.
iv)SDO Shahdadpur	661	150.00	99150	87.00	22107	43.50	12071	3925	208025	25.00	5284	23850	119250	4.00	508	0.00	0	367245	EW=43.5, LEAD 200 FT.
						4.00	1157											1157	EW=4.0, LEAD 250 FT.
DIV. TOTALS	1998	150.00	299700	265.60	67489	160.30	43926	18455	978115	45.50	9616	39235	196175	4.00	508	0.00	0	1295830	WORKS COST/TRAC.USE COST= 4.35
DIVISION WISE %AGES OF WORK'S COST TO TOTAL COST OF WORKS IN THE DIVISION					5		3		75		1		15		0		0	100	

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ISM–II
O&M EQUIPMENT TRIAL
COST ANALYSIS

Province / Division & Sub-division	Total No of hrs tractor was used	Hourly rate of equip. use	*** Cost of equip. use	Description of works performed and units: Earth work & its supply incl 100 ft. lead (1000 cft)		Earth work supply incl. lead in excess of 100 ft. (1000 cft)		Grading levelling and prep. of earth surfaces. (1000 sft)		Silt clearance from canal beds (1000 cft)		Sprinkling water on tracks (1000 @ 1000sft)		Rehandling of earth, load upto 50 ft (1000 cft)		Transport of material (100 cft)		** Total cost if contracting of same work if done on scheduled rates	REMARKS
				RATES IN RUPEES WITH APPLICABLE PREMIUM *															
				P 195.90		P –See Schedule		P = Rs.44.77		P –See Schedule		P = 5.0		S =127.05,earth		P = NA			
				S 254.10		S –See Schedule		S = Rs.53.00		S –See Schedule		S 5.0		N =101.50, earth		S –See Schedule			
				N		N =		N =		N –		N = 5.0		N =290.50, shingle		N =			
SINDH				B 587.25		B –See Schedule		B = Rs.74.70		B NA		B = 5.0		B =139.00		B –See Schedule			
JAMRAO DIV.	Hrs	Rs/Hr	Rs	Quant	Cost Rs.	Quant.	Cost Rs.	Quant.	Cost Rs	Quant.	Cost Rs	Quant.	Cost Rs.	Quant	Cost Rs.	Quant	Cost Rs.		
i) XEN Jamrao	350	150.00	52500	5.30	1347	31.75	9192	750	39750	0.00	0	0	0	0.00	0	0.00	0	50288	EW 31.5, LEAD 200 FT.
ii)SDO Mirpurkhas	842	150.00	126300	78.90	20048	44.20	15368	2890	153170	0.00	0	6350	31750	0.00	0	0.00	0	220337	EW 44.2, LEAD 500 FT.
						3.80	3493											3493	EW 3.8, LEAD ONE MILE.
iii)SDO Jhol	2038	150.00	305700	0.00	0	366.50	136008	0	0	0.00	0	3306	16530	0.00	0	0.00	0	152538	EW 366.5, LEAD 600 FT.
						110.00	100903											100903	EW 110.0, LEAD ONE MILE.
iv) SDO Khadro	946	150.00	141900	0.00	0	70.50	21213	0	0	0.00	0	0	0	348.50	44277	100.00	11877	77367	EW 70.5, LEAD 300 ft.
						15.40	4814											4814	EW 15.4, LEAD 350 ft.
						12.60	11558											11558	EW 12.6, LEAD ONE MILE.
DIV. TOTALS	4176	150.00	626400	84.20	21395	626.75	286178	3640	192920	0.00	0	9656	48280	348.50	44277	100.00	11877	604927	WORKS COST/TRAC.USE COST= 0.97
DIVISION WISE %AGES OF WORK'S COST TO TOTAL COST OF WORKS IN THE DIVISION					4		47		32		0		8		7		2	100	
PROV. TOTALS	9420	150.00	1413000	852.00	216503	898.12	412054	28937	1533661	45.50	9616	54956	274780	352.50	44785	100.00	11877	2503277	WORKS COST/TRAC.USE COST= 1.77
PROVINCE WISE %AGE OF WORK'S COST TO TOTAL COST					9		16		61		0		11		2		1	100	

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ISM-II
O&M EQUIPMENT TRIAL
COST ANALYSIS

Province / Division & Sub-division	Total No of hrs tractor was used	Hourly rate of equip use	*** Cost of equip. use	Description of works performed and units: Earth work & its supply incl. 100 ft. lead 1000 cft	Earth work supply incl. lead in excess of 100 ft. 1000 cft	Grading levelling and prep. of earth surfaces 1000 sft	Silt clearance from canal beds 1000 cft	Sprinkling water on tracks 1000 @ 1000 cft	Rehandling of earth, lead upto 50 ft 1000 cft	Transport of material 100 cft	** Total cost if contracting of same work if done on scheduled rates	REMARKS
				RATES IN RUPEES WITH APPLICABLE PREMIUM *								
				P 195.90	P =See Schedule	P = Rs.44.77	P See Schedule	P = 5.0	S =127.05, earth	P = NA		
				S 254.10	S =See Schedule	S = Rs.53.00	S =See Schedule	S = 5.0	N =101.50, earth	S =See Schedule		
				N	N =	N =	N =	N = 5.0	N =290.50, shingle	N =		
				B 587.25	B =See Schedule	B = Rs.74.70	B = NA	B = 5.0	B =139.00	B =See Schedule		
BALOCHISTAN												
PAT FEEDER DIV	Hrs	Rs/Hr	Rs	Quant. / Cost Rs.	Quant. / Cost Rs.	Quant. / Cost Rs.	Quant. / Cost Rs.	Quant. / Cost Rs.	Quant. / Cost Rs.	Quant. / Cost Rs.		
Pat Feeder Div												
i)XEN Pat Feeder	536	150.00	80400	2.00 / 1175	3.09 / 1907	5290 / 395163	0.00 / 0	5290 / 26450	0.00 / 0	0.00 / 0	424695	EW=3.09, LEAD 200 FT.
ii)SDO Dera Murad Ja	944	150.00	141600	31.00 / 18205	16.80 / 10370	4900 / 366030	0.00 / 0	10005 / 50025	0.00 / 0	0.00 / 0	444630	EW=16.8, LEAD 200 FT.
iii)SDO Hair Din	933	150.00	139950	12.19 / 7159	7.35 / 9818	6237 / 366030	0.00 / 0	450 / 2250	0.00 / 0	0.00 / 0	385256	EW=7.35, LEAD 2 KM.
iv)SDO Gath Tagin	634	150.00	95100	11.50 / 6753	26.58 / 41246	6250 / 366030	0.00 / 0	1580 / 7900	0.00 / 0	0.00 / 0	421929	EW=26.58, LEAD 3 KM.
v)SDO Pat Pat	1019	150.00	152850	12.28 / 721.	8.60 / 11487	7752 / 366030	0.00 / 0	10320 / 51600	0.00 / 0	0.00 / 0	436329	EW=8.60, LEAD 2 KM.
PROV. TOTALS	4066	150.00	609900	68.97 / 40503	62.42 / 74828	30429 / 1859283	0.00 / 0	27645 / 138225	0.00 / 0	0.00 / 0	2112838	WORKS COST/TRAC.USE COST= 3.46
PROVINCE WISE %AGE OF WORK'S COST TO TOTAL COST					2	4	88	0	7	0	100	
NWFP												
Southern Canal Circle												
i)SE SCC Bannu	13	150.00	1950	0.00 / 0	0.00 / 0	0 / 0	0.00 / 0	0 / 0	0.00 / 0	0.00 / 0	0	
ii)SDO Head Works	457	150.00	68550	0.00 / 0	119.00 / 48325	150 / 6716	0.00 / 0	150 / 600	0.00 / 0	0.00 / 0	55640	
iii)SDO Sarai Naurang	115	150.00	17250	0.00 / 0	0.00 / 0	468 / 20952	0.00 / 0	0 / 0	0.00 / 0	0.00 / 0	20952	
iv)SDO Pahar Pur	64	150.00	9600	0.00 / 0	0.00 / 0	0 / 0	0.00 / 0	0 / 0	0.00 / 0	0.00 / 0	0	
PROV. TOTALS	649	150.00	97350	0.00 / 0	119.00 / 48325	618 / 27668	0.00 / 0	150 / 600	0.00 / 0	0.00 / 0	76593	WORKS COST/TRAC.USE COST= 0.69
PROVINCE WISE %AGE OF WORK'S COST TO TOTAL COST					0	63	36	0	1	0	100	
PROJ.TOTALS	26748	150.00	4012200	2302.69 / 527680	2409.21 / 954889	85174 / 4528892	637.10 / 99900	97090 / 483400	352.50 / 44785	126.00 / 15777	6655323	WORKS COST/TRAC.USE COST= 1.67
PERCENTAGE OF EACH WORK'S COST TO TOTAL COST OF ALL WORKS COMPLETED UNDER THE TRIAL.					8	14	68	2	7	1	100	

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* For civil works rates applicable in each province are used.
** This is equal to to the contractual cost of the performed civil works.
*** This is equal the cost of equipment use for # of hrs to perform the works described in ** above @ Rs 150.00/hr.

EVALUATION OF O&M MECHANIZATION PROGRAM IN THE PROVINCIAL IRRIGATION DEPARTMENTS

ANNEX IX

Equipment Use and Admnistration

WORKS WHICH CAN BE PERFORMED WITH THE O&M EQUIPMENT

The works which may be carried out with the help of the O&M equipment are given in the following paragraphs.

It is worth mentioning that the tractor and equipment are meant for the routine maintenance of channels. Routine maintenance of channels is defined as those tasks which are performed daily/weekly/or on regular interval basis by PIDs. It is particularly applicable to:

- **Maintenance of service road to keep them in motorable condition,**
- **Repairing rain cuts and rodent holes,**
- **Killa bushing,**
- **Maintaining the freeboard, embankment and outer slopes,**
- **Removing floating debris,**

Although the tractor and equipment are capable of carrying out large quantities of work they are primarily meant for light maintenance. The channel banks which have deteriorated very badly may need special repairs or complete rehabilitation. Such works will have to be let out to the contractors or done by the mechanical divisions. If the tractor and equipment starts doing major repairs then it may not be available to perform the routine maintenance of the channels in the sub-division for which it is meant.

All the above works are chargeable to M&R of canals for which funds are demanded in the budget.

I. Maintenance of Service Roads

(a) Levelling of the road surface.

This is now being done by the beldars who normally uses "Ring Bath" for levelling the road track and filling the ruts.

(b) Watering of the road.

The sprinkling of water is now done manually with the help of a bucket by the beldar.

The jurisdiction of the beldar is two miles on main canals and branches and six miles on distributaries and minors. The beldar also has the operational responsibilities of patrolling the channels in his beat. He has also to remove the floating debris from the channels. In view of the socio-political changes resulting in continuous forced flow of traffic, the maintenance of road by the beldars has gone much beyound his capacity. The deterioration to the system has occurred to such an extent that special efforts may have to be made to bring them in proper state of maintenance

With the present situation, either this work be given out on contract, which could be very costly then the available resourses, or, as an alternative mechanized maintenance may be performed.

In the mechanized process, roads can be levelled precisely with the help of the grader blade and sprinkled with the help of water sprinkler trailer. This process could be repeated once or twice during the month depending on the level of use.

The jurisdiction of one sub-divisional officer normally extends from 125 miles to 150 miles of channels, which are controlled by three or four sub-engineers. The tractor and equipment with the SDO will thus have to be distributed equally to carry out the maintenance of the road and watering. Work plan for carrying out works in each section would cover the use of equipment in each sub-engineer's section according to the condition of the roads and the canal banks in that section.

II. Filling of Rain-Cuts on Channels and Rodent Holes

For proper filling of rain-cuts or rodent holes, it is necessary to open up the rain-cuts and then fill them with soil, water and compact it. Some times the soil of the canal bank is very hard and opening of the rain-cuts may be very difficult for the beldars. This could be quickly done with the help of chisel plow and then dozing the excess soil from outside the roadway of the channel or hauling the soil on the trailer from a distance. Spreading of earth, its levelling, and sprinkling of water can be done mechanically.

III. Filling Up of the Cattle Ghats of the Channel

Most of channels have been badly damaged at some locations by the continuous cattle trespass. On the motorable side of the channels, these ghats could be filled up with soil by bringing the soil in the tipping trolley from outside and by dozing the soil from the toe of the bank. In case the fields along the cattle ghat are lying vacant, then it could be plowed with the help of chisel plough and then loose soil dragged to the toe of the bank with rear blade and then dozing to fill up the ghat site.

IV. Minor Earthen Repairs to the Channels
(Borrow area being not available adjacent to the site)

On most of the channels, dangerous cattle ghats are formed and very little freeboard is left, also no soil is available nearby because of crop growth all along the channel. In such cases soil be borrowed from the sections where it is available and could be transported in the tipping trailer and off-loaded at such locations to repair such ghats. Repairs to such weak sites/ghat sites are beyond the capacity of beldars. Repairs to weak sites and ghat sites are normally given out on contract basis according to the normal schedule. Because of non-availability of funds these

repairs are often deferred resulting in added deterioration.

V. Closing of Breaches and Strengthening of Breach Sites

The equipment can be used to bring the earth for closing of breaches on channels and also for strengthening of the channels at such weak/breach sites. This can be done by bringing the earth with the help of dozer blade, rear blade, or the tipping trolley.

VI. Silt Clearance from Channel Beds During Closure

During closure period, when the channels are dry, the tractor can enter. Silt heaps can be broken with the help of chisel plough and then the silt and other trash material can be taken out of the channel by using the rear blade and then front dozer blade.

Similarly it could be possible to close the ghat sites by pushing the silt from the bed of the channel to such ghats sites and then closing the weak and ghat sites with silt and covering with clayey earth.

VII. Removal of Fallen Trees from the Canal Banks

The tractors can be used to remove the fallen trees from the canal banks or from the channel. In some areas wind storms are a normal feature and during these wind storms, many small and even big trees or big branches fall down in the canal and may require a big effort for removal. With the tractor being available, the trees could be removed from the canal after cutting them in to suitable lengths and dragging them with the help of the log chain or steel wire rope.

VIII.Removal of Silt Heaps from the Channel Banks

In the tail reaches of distributaries and minors, huge heaps have formed due to deposit of desilted material along the banks. The heaps have become so high that it is not possible to desilt the channels further, as the silt would come back in to the channels. The use of front dozer blade and rear grader blade the silt can be pushed to the outer side of the bank and enough space can be gained for further desilting. Normally such works are given out on contract, but could be performed with the help of the tractor.

IX. Transporting of Bushing for Replenishing the Killa Bushing in Eroded Reaches of the Channels

Killa bushing is a normal feature to arrest the further erosion of the channel section. After killas have been fixed in the bed of the channel to make the bed width as per design, then in between the killas whittling of brushwood is carried out. This bushing is some time not available from the trees nearby and has to be brought from long distances. The bushing required for filling in between the killas, and its replenishment on weekly or fortnightly basis depending upon the deposition of silt in the eroded sites is very essential. Bushing can be transported from long distances with the help for tractor and trolley.

SCHEDULING OF THE O&M EQUIPMENT AND PREPARATION OF THE WORK PLAN

For the proper scheduling of the tractor and equipment it is important to prioritize the works and then prepare the work plan for one year or on six-month basis.

Before the preparation of work the plan, the SDOs should visit all the channels in the sub-division along with their sub-engineers and prepare priorities for under taking the routine maintenance of the channels in each section.

A tractor will be considered well utilized if total work hours are 80-120 during the month. For the purpose of scheduling 100 hours have been considered as most modest level of use. With a suitable workplan, the SDOs would ensure that sub-engineers utilize the tractor equipment at the desired level, and get maximum work done. Each sub-division having four sub-engineer's sections, the tractor with SDO would be utilized for 400 hrs during the a workplan year by each of the three sub-engineers.
According to the distribution of hours, each sub-engineer can list the works for sub-divisional workplan prepared by the SDO. The list of works and their probable cost will then be included in the annual budget of the division. The executive engineer incharge of the division is recommended to monitor the use of tractor and the equipment and keep close watch to ensure that workplan targets are being achieved.

ESTABLISHMENT OF THE BUDGET

Since 1980-81, the Sub-heads provided were given code Nos. as have been explained below, and these Sub-heads were covered under Maintenance & Repair (M&R).

6-52300 Canal Irrigation M&R

44000 Building Structures
44100 Office Building
44200 Residential Building
44300 Other Buildings
44500 Irrigation

45100 Main Canals
a) Unlined
- 1 Main canals & branches
- (i) Upto 6000 cfs discharge.
- (ii) More than 6000 cfs to 10,000 cfs Discharge.
- (iii) More than 10,000 cfs discharge.
- 2 Link canals
- (i) Upto 10,000 cfs discharge
- (ii) More than 10,000 cfs discharge

b) Lined
Link canals, main canals and branches

6-52300-45300 Tributary and other subsidiary links distributaries, minors, and subminors.

In year 1982, yardsticks for the grant of maintenance and repair to the Irrigation and Power Department works were approved by the Finance Department letter no: 6(18)87-D-III/FD dated October 21, 1992. While preparing the budget and request for demand, the amount demanded would not exceed what is calculated with this yard stick.

When the budget demand is prepared by any division the list of the works proposed to be executed with the demanded amount is always supplied in support of the demand.

In this list, provision for repairing and watering of the roads, repair to the weak sits and ghats sites, and all other works which could be done with the help of the equipment and tractor should be provided accurately to the works listed in the work plan.

The total cost of the works which could be carried out in 1200 hours by one tractor of SDO's unit would not exceed Rs. 85,000 @ Rs. 71 per hour operational cost. The important task is to get some surety from the Government that Rs. 85,000 would be released for the O&M equipment in each sub-division to carry out the documented works. It is important that for the O&M Equipment an equivalent amount is also released under the **Suspense Head.**

The issuance of letter from the Secretary of Government Irrigation and Power Department that the amount resumed for the operation and maintenance work by using the equipment under the head M&R and an equivalent amount suspense head released should be used only for the works for which it has been released, is also desired.

The total amount needed for the operation and maintenance of tractor and equipment would not exceed Rs. 350000 for the four divisional tractors, in any demand under M&R according to the revised yardstick.

The belders who used to be work charged establishment have been absorbed as regular establishment of the Irrigation Deptt. under head 6-52300-01200 and do not affect the M&R budget.

It may be desirable that up to two vacancies of the beldars/mates in a sub-division be converted in to operaters of the tractor so that Government does not have to create additional jobs.

ALLOCATION OF FUNDS

At present PIDs have different procedures of fund allocation. The provincial procedures are given below.

PUNJAB

In Punjab funds are released to the divisions and the executive engineers distribute these funds to the subdivisions.

The divisions in Punjab according I.M.O Para 2.3 charge the operation and maintenance of the tractor and equipment and jeeps to the suspense head. The initial booking of the P.O.L and the work charge staff employed is charged to the suspense head. Ultimately the equipment expense is charged to the M&R estimates prepared for the works executed and then the same is adjusted through book adjustment giving credit to the suspense head and debiting the same to the works executed with the help of the O&M equipment.

In this situation the divisions in Punjab would need funds under the suspense head as well as under the head M&R. The funds released under M&R should be enough so that the suspense account is cleared at the end of the year.

The works which will be executed by O&m equipment would be the works normally are covered under M&R and could be easily charged to existing M&R budget under head 06 - 52300 - 45100 & 54300.

The budget is prepared according to new revised yard stick which could be 45 to 50 lacs or even more in certain divisions.

The budget estimate is supported by the list of works which is proposed to carried out during the next financial year alongwith

their estimated cost. The only requirement would be that the works on which the O&M equipment would be used are provided in the budget according to the work plan prepared for uses of O&M equipment. It is estimated that a total demand for works which could be executed with the use of O&M equipment would hardly be five to seven percent of the total demand under normal M&R of the Division. Thus it should ensured that:

a) This amount of Rs. 85,000 is released for each one sub-division for O&M equipment.

b) The amount released should be used only on works which are to be executed with O&M equipment and a binding should be made on the XEN concerned to use this amount for these works. Special notification in this regard is desired.

SINDH

In Sindh there is no suspense head and the Operation and Maintenance of O&M equipment is directly charged to M&R sub-head - 6-52000 Irrigation - 43300 Canal Irrigation. The program for the works to be executed by the divisions under the sub-head of "Maintenance and Repairs" is approved by the Chief Engineer.

For example, the revised program for 1991-92 is received duly approved by CE by Executive Engineer Fuleli Canal Division and the amount of the estimate for O&M equipment is also included in this program for Rs. 172,000/- (from Oct 1991 - June 1991). Similarly the amount of "estimate for O&M equipment" provided to the Fuleli Canal Division, is also included in the works programe for the year 1992 - 1993 for an amount of Rs. 282,482. It is quite obvious that the funds when released would be spent for the O&M equipment use.

Similarly the estimate is charged to sub-head M&R 520 - Irrigation 523 - 459 M&R II M.C & Br - & II Dys & Mrs. in Jamrao Canal Division.

The estimates in Hala Division are charged to 520 - Irrigation & 523-459 (M&R to Canals & Dys).

Since the estimates are chargeable to M&R and the funds are allocated to the Divisions, the executive Engineers are at liberty to use the funds to cover the cost of other works rather than using the funds specially for the operation and maintenance of O&M equipment. In this regard it is desired that Secratory I&P to issue special directive restricting the use of O&M equipment funds specifically for equipment operation.

BALOCHISTAN

In Balochistan Province, funds are released for the maintenance and repair to the channels with the help of machines and necessary allocations are made according to the POL and other O&M and repairs to the machinery each year. Since the O&M and repair of this equipment has also been provided under that sub-head so there is no operational constraint in Balochistan.