TSN 78160
PD ABE430

A.I.D. EVALUATION SUMMARY - PART I

1. BEFORE FILLING OUT THIS FORM, READ THE ATTACHED INSTRUCTIONS.
2. USE LETTER QUALITY TYPE, NOT "DOT MATRIX" TYPE

IDENTIFICATION DATA

A. Reporting A.I.D. Unit:
Mission or AID/W Office: USAID/INDIA
(ES# _____)

B. Was Evaluation Scheduled in Current FY Annual Evaluation Plan?
Yes [X] Slipped [ ] Ad Hoc [ ]
Evaluation Plan Submission Date: FY 90 Q 3

C. Evaluation Timing
Interim [ ] Final [X]
Ex Post [ ] Other [ ]

D. Activity or Activities Evaluated (List the following information for project(s) or program(s) evaluated; if not applicable, list title and date of the evaluation report.)

Project No.	Project /Program Title	First PROAG or Equivalent (FY)	Most Recent PACD (Mo/Yr)	Planned LOP Cost (000)	Amount Obligated to Date (000)
386-0490	Maharashtra Minor Irrigation	1984	09/92	$47,000	$47,000

ACTIONS

E. Action Decisions Approved By Mission or AID/W Office Director Action(s) Required	Name of Officer Responsible for Action	Date Action to be Completed
1. Use Liaison and Coordination Unit (LCU) funds to document the successes and lessons learned in the form of video to sensitize irrigation and agricultural officers in the concerned governments as well as water users and farmers on the innovations emerging from the project.	NRM	August 30, 1992
2. Extend the PACD from 09/30/91 to 09/30/92 and make it coterminus with the TDD to ensure the completion of at least 70 minor irrigation schemes in progress and stop and offset the payments for 15 schemes which are not going to be completed.	NRM / PDPS	August 30, 1991
3. Identify the follow-up technical, research, training and institutional development activities which could be supported under some appropriate funding mechanism after the extended PACD.	NRM / PDPS	March 15, 1992

(Attach extra sheet if necessary)

APPROVALS

F. Date Of Mission Or AID/W Office Review Of Evaluation: (Month) July (Day) 26 (Year) 1991

G. Approvals of Evaluation Summary And Action Decisions:

	Project/Program Officer	Representative of Borrower/Grantee	Evaluation Officer	Mission or AID/W Office Director
Name (Typed)	B.N.Maheswari		B.R. Patil	Walter G. Bollinger
Signature	[signature]		[signature]	[signature] for
Date	4-21-92		4/19/92	5/7/92

ABSTRACT

H. Evaluation Abstract (Do not exceed the space provided)

1. Project Purpose: The purpose of the USAID assisted Maharashtra Minor Irrigation Project was to increase irrigation efficiency and net returns from investments with employment increases in ninety minor irrigation projects in the state of Maharashtra.

2. Evaluation Purpose: The evaluation purpose was to critically examine the issues related to 10 aspects of the project and make suitable recommendations. They are: i) Performance based disbursements; ii) standards and procedures; iii) performance testing; iv) institutional development and linkages; v) water users' associations and farmer's participation; vi) organizational and staff capabilities; vii) computerized management information system; viii) water and land practices; ix) follow-up measures taken after last evaluation.

3. Evaluation Methodology: The evaluation team spent two weeks in Maharashtra, studied the reports, interviewed officers and farmers concerned, and used available data to provide answers to evaluation questions listed in the scope of work.

4. Findings:

i) Performance Related Systems and Procedures - Four Benchmarks, skillfully phased for desired performance accomplishments, as used in this procedure were found to be very effective for achieving improved project planning, design, farmer organization and participation, and obtaining balanced implementation.

ii) Institutional and Organizational Development - The establishment of new organizations in the Irrigation Department were observed to be in place and working effectively.

The project has been successful in forming active farmer outlet committees. The linkage between these farmer groups and the Irrigation staff was observed to be genuinely very good. The organizational staff and capabilities within the Irrigation Department were found to be excellent. The organizational improvements, special studies, pilot activities and training programs have played a major role in the improvement of minor irrigation system design and operations and staff capabilities. Computerization of the irrigation management information system has been vigorously adopted by MMIP.

iii) Project Impact Related Matters - The impact of MMIP will not be limited to improved irrigation water delivery alone, but will require the use of improved irrigation practices on farmer's fields prepared for these new and more efficient methods of water application. Hydro-meterological stations will add to Maharashtra's ability to modernize century old runoff equations and to use computerized models for design and water management.

COSTS

I. Evaluation Costs

1. Evaluation Team Name	Affiliation	Contract Number OR TDY Person Days	Contract Cost OR TDY Cost (U.S. $)	Source of Funds
Mr. Donald W. Haslem	Winrock International	PDC-1406-I-00-0032-00	$55,000	Project
Mr. Thomas P. Weaver	Winrock International	- do -	$55,000	- do -
Mr. A. N. Michael	Purchase Order	386-0490-0-00-1166	$ 5,780	- do -
Mr. B. P. Bhatnagar	Purchase Order	386-0490-0-00-1163	$ 8,565	- do -

2. Mission/Office Professional Staff Person-Days (Estimate) _____

3. Borrower/Grantee Professional Staff Person-Days (Estimate) _____

A.I.D. EVALUATION SUMMARY - PART II

SUMMARY

J. Summary of Evaluation Findings, Conclusions and Recommendations (Try not to exceed the three (3) pages provided)
Address the following items:

- Purpose of evaluation and methodology used
- Purpose of activity(ies) evaluated
- Findings and conclusions (relate to questions)
- Principal recommendations
- Lessons learned

Mission or Office:	Date This Summary Prepared:	Title And Date Of Full Evaluation Report:
USAID/INDIA	March 1992	Maharashtra Minor Irrigation Project:Final Evaluation Report (July 1991)

1. Project Purpose: The purpose of the USAID assisted Maharashtra Minor Irrigation Project was to increase irrigation efficiency and net returns from investments with employment increases in ninety minor irrigation projects in the state of Maharashtra.

At the time of this evaluation (July 1991) all 90 of the new minor irrigation schemes had completed the first two performance benchmarks (planning, design, and farmer participation in chak layout), 59 have met the requirements of the third benchmark (completion of headworks, 75% of the distribution system and 30% of Part I works), and 28 have reached the forth benchmark (completion). Out of nine approved studies five have been completed and four are ongoing. Diagnostic analysis of 12 planned studies of existing MIS have been accomplished. Eight pilot activities were planned and seven are ongoing while one has been discontinued for economic reasons. Three new in irrigation department institutions have been created and one has been reorganized. Training courses conducted in various water management related subjects have been extended to 1867 Irrigation Department (ID) and Agricultural Department (AD) staff members. Computerized design, water management and operational activities have emerged as a major MMIP components. Of the 52 hydro-meterological stations to be constructed, 32 have been completed and 20 are in various stages of progress.

2. Evaluation Purpose: The evaluation purpose was to critically examine the issues related to 10 aspects of the project and make suitable recommendations. They are: i) Performance based disbursements; ii) standards and procedures; iii) performance testing; iv) institutional development and linkages; v) water users' associations and farmer's participation; vi) organizational and staff capabilities; vii) computerized management information system; viii) water and land practices; ix) follow-up measures taken after last evaluation.

3. Evaluation Methodology: The evaluation team spent two weeks in Maharashtra, first in beneficial discussions with GOM/ID officials in Bombay and Pune, Aurangabad, Nagpur, and Amravati regions. The team also studied the reports, interviewed officers and farmers concerned, and used available data to provide answers to evaluation questions listed in the scope of work.

4. Findings:

i) Performance Related Systems and Procedures - The use of performance oriented conditions and goals has proven to be very effective on MMIP. Disbursements of donor assistance funds based on structured performance objectives has been very popular with GOM and USAID officials alike. Four Benchmarks, skillfully phased for desired performance accomplishments, as used in this procedure were found to be very effective for achieving improved project planning, design, farmer organization and participation, and obtaining balanced implementation. Performance and operation testing were devised as a means to verify the requirements of Benchmarks III and IV respectively. They have proven to be extremely effective for this purpose and resulted in establishing farmer's confidence by assuring them that adequate irrigation streams can reach their holdings.

ii) Institutional and Organizational Development - The establishment of new organizations in the Irrigation Department were observed to be in place and working effectively. The formation of the Liaison and Coordination Unit was the catalyst in the success of MMIP. The Agricultural Department was unable to provide the proposed level of support, making it necessary to bring in State Agricultural Universities to fill this void.

The project has been successful in forming active farmer outlet committees. The linkage between these farmer groups and the Irrigation staff was observed to be genuinely very good. There is a guarded interest by these committees in establishing water users associations (or tank committees) for the minor schemes, as a whole. The organizational staff and capabilities within the Irrigation Department were found to be excellent. The organizational improvements, special studies, pilot activities and training programs organized within MMIP have played a major role in the improvement of minor irrigation system design and operations and in improving staff capabilities for these schemes. Computerization of the irrigation management information system has been vigorously adopted by MMIP which has the potential to yield immense benefits to the project and to the management of all irrigation schemes in Maharashtra.

iii) Project Impact Related Matters - The impact of MMIP will not be limited to improved irrigation water delivery alone, but will require the use of improved irrigation practices on farmer's fields prepared for these new and more efficient methods of water application. Hydro-meterological stations will add to Maharashtra's ability to modernize century old runoff equations and to use computerized models for design and water management.

The economic potential created by MMIP, which is only now beginning to become apparent, has the capacity to become highly significant. The higher cropping intensities, interest of farmers in growing high valued crops, and the conjunctive use of groundwater are among the numerous factors that will play a part in the economic equation. The indicated rapid growth of rabi irrigation created by MMIP will also create an increase in agricultural and agriculturally related employment.

5. Recommendations:

i) Successful and well accepted performance based measures, as well as their enhancement throughout the State and to other areas of India, should be encouraged and promoted with stress on the importance of farmer involvement in these activities.

ii) The team felt that the proposed chak demonstrations in each scheme was important to enhance the improved irrigation provided by MMIP and there is a need to strengthen these by increased involvement from the Agricultural Department. Training courses have been beneficial to primarily ID staff involved in MMIP and need to be continued and extended to other participating agencies. This is particularly true in the case of computer use. It has been recommended that the scope of the computerized management system should be extended to include software for additional analysis of some irrigation issues relating to environmental sustainability.

iii) Agriculture and Irrigation Departments of GOM should pay more attention to supporting and encouraging the implementation of water and land management practices.

iv) The entire MMIP should be extended for a period of one year and that those technical assistance and information gathering components supported by grant funds should be extended for a full three years. A suitable method needs to be found for continuing these needed and beneficial activities.

ATTACHMENTS

K. Attachments (List attachments submitted with this Evaluation Summary; always attach copy of full evaluation report, even if one was submitted earlier; attach studies, surveys, etc., from "on-going" evaluation, if relevant to the evaluation report.)

Copy of the report

COMMENTS

L. Comments By Mission, AID/W Office and Borrower/Grantee On Full Report

1. All evaluation issues and questions are properly addressed and carefully examined.

2. Detailed recommendations on each issue are listed separately for the consideration of AID and GOI.

3. The package of sound irrigation management practices emerging from the project is highlighted and strong recommendations are made to replicate that throughout the state and the country and document the successes.

4. Lower priority findings and detailed programmatic recommendations warrent greater attention from the concerned state and department in future.

5. Executive summery is too long and most of the broad recommendations made to AID and GOI are acceptible.

USAID ASSISTED

MAHARASHTRA MINOR IRRIGATION PROJECT

(386-0490)

FINAL EVALUATION REPORT

JULY, 1991

Winrock International and USAID Consultant Team
INDIA

EXECUTIVE SUMMARY

MAHARASHTRA MINOR IRRIGATION PROJECT (MMIP)

Introduction

The objective of the USAID assisted Maharashtra Minor Irrigation Project was to increase irrigation efficiency and net returns from investments with employment increases in ninety minor irrigation projects in the State of Maharashtra. The project involved funds for construction and for institutional development and support activities.

The project, when viewed as a whole, has established a "package of practices" which may be essential for achieving dramatic increases in the productivity of investment in irrigation and coincidentally for managing minor irrigation system in an environmentally sustainable way. None of the elements of this total package is new. What is new is the manner in which they have been joined to produce a different approach to minor irrigation development in Maharashtra .

The elements of this package of practices for irrigation development are, (1) a series of benchmarks during the construction phase which tie disbursements to defined stages of both works and institutional development, including the formation of farmer's organizations and the involvement of the farmers in laying out of the field channels, (2) the carrying out of a series of performance tests of the distribution system to determine if it is capable of delivering water up to design standards and correcting any deficiencies, (3) a computerized crop planing and water scheduling system that includes participation of the farmer, (4) the formation of farmer organizations that are eventually to be

responsible for the operation and maintenance of the entire works for water distribution and, (5) a set of activities to facilitate the introduction of irrigated agriculture and follow up support by the Irrigation Department who will maintain the dam site and provide assistance in planning the cropping patterns and water rotations consistent with water needs and the available water supply.

Background

The MMIP provided for the construction of 90 new schemes; the rehabilitation of 12 existing minor irrigation schemes; the establishment of 52 hydro-meteorological stations; the training and development of 1805 Irrigation Department staff; the establishment of computer facilities within the irrigation department and the development of computer design and water management systems: the taking up of 10 special studies, 12 diagnostic analyses, and 8 primary pilot activities; and the conducting of activities to ensure participation and involvement of farmers.

At the time of this evaluation (July 1991) all 90 of the new minor irrigation schemes had completed the first two performance benchmarks (planning, design, and farmer participation in chak layout), 59 have met the requirements of the third benchmark (completion of headworks, 75% of the distribution system and 30% of Part I works), and 28 have reached the forth benchmark (completion). Out of nine approved studies five have been completed and four are ongoing. Diagnostic analysis of 12 planned studies of existing MIS have been accomplished. Eight pilot activities were planned and seven are ongoing while one has been discontinued for economic reasons. Three new GOM/ID institutions have been created and one has been reorganized. Training courses conducted in various water management related subjects have been extended to 1867 ID and AD staff members. Computerized design , water management and operational activities have emerged as a major

MMIP components. Of the 52 hydro-meteorological stations to be constructed, 32 have been completed and 20 are in various stages of progress.

Evaluation Methods

The Evaluation Team spent two weeks in Maharashtra, first in beneficial discussions with GOM/ID officials in Bombay and Pune and then visiting 11 different Minor Irrigation Schemes in Pune, Aurangabad, Nagpur, and Amravati regions. Ten critical issues were used as the major focus of the evaluation and are covered in the main body of the report. They are: (a) performance based disbursements, (b) standards and procedures, (c) performance testing, (d) institutional development and linkages, (e) water users' associations and farmer's participation, (f) organizational and staff capabilities, (g) computerized management information system, (h) water and land practices, (i) production, income,and employment gain, and (j) follow-up measures taken after last evaluation. These central issues are grouped into three aspects which are used to briefly relate the findings of the Evaluation Team as follows:

(1) Performance Related Systems and Procedures

The use of performance oriented conditions and goals has proven to be very effective on MMIP. Disbursement of donor assistance funds based on structured performance objectives has been very popular with GOM and USAID officials alike. Four Bench Marks, skillfully phased for desired performance accomplishments, as used in this procedure were found to be very effective for achieving improved project planning, design, farmer organization and participation, and obtaining balanced implementation. Performance and operation testing were devised as a means to verify the requirements of Bench Marks III and IV respectively. They have

proven to be extremely effective for this purpose and resulted in establishing farmer's confidence by assuring them that adequate irrigation streams can reach their holdings.

The perpetuation of these successful and well accepted performance based measures, as well as their enhancement throughout the State and to other areas of India, has been recommended by the Evaluation Team. These recommendations also include and stress the importance of farmer involvement in these activities. Consistent with this recommendation, the GOM/ID is currently circulating a draft of an order that will require performance testing on all newly constructed minor irrigation projects in the entire State of Maharashtra

Institutional and Organizational Development

The establishment of new organizations in the Irrigation Department were observed to be in place and working effectively. The formation of the USAID assisted Liaison and Coordination Unit, which functioned as an independent entity, was the catalyst in the success of MMIP. The Agricultural Department was unable to provide the proposed level of support, making it necessary to bring in State Agricultural Universities to fill this void. Although there are established linkages between the various participating Agencies the actual working ties need to be improved.

The project has been successful in forming active farmer outlet committees. The linkage between these farmer groups and the Irrigation staff was observed to be genuinely very good. There is a guarded interest by these committees in establishing water users associations (or tank committees) for the minor schemes, as a whole. The organizational and staff capabilities within the Irrigation Department were found to be excellent. The organizational improvements, special studies, pilot activities and training programs organized within MMIP have played a major role in

the improvement of minor irrigation system design and operations and in improving staff capabilities for these schemes. Computerization of the irrigation management information system has been vigorously adopted by MMIP. Although this technology is comparatively new to the project and additional time and equipment will be necessary for it to be fully incorporated into the system, computerization has the potential to yield immense benefits to the project and to the management of all irrigation schemes in Maharashtra.

The Team felt that the proposed chak demonstrations in each scheme was important to enhance the improved irrigation provided by MMIP and there is a need to strengthen these by increased involvement from the Agriculture Department. Training courses have been beneficial to primarily ID staff involved in MMIP and need to be continued and extended to other participating agencies. This is particularly true in the case of computer use. It has been recommended that GOM/ID extend the scope of the computerized management system to include software for additional analysis of some irrigation issues relating to environmental sustainability.

Project Impact Related Matters

The impact of MMIP will not be limited to improved irrigation water delivery alone, but will require the use of improved irrigation practices on farmer's fields prepared for these new and more efficient methods of water application. Hydro-meteorological stations will add to Maharashtra's ability to modernize century old runoff equations and to use computerized models for design and water management,

The economic potential created by MMIP, which is only now beginning to become apparent, has the capacity to become highly significant. The higher cropping intensities, interest of farmers in growing high valued crops, and the conjunctive use of

groundwater are among the numerous factors that will play a part in the economic equation. The indicated rapid growth of rabi irrigation created by MMIP will also create an increase in agricultural and agriculturally related employment.

Work is underway on hydrological analysis, however, meaningful results are likely to require another three years. Benchmark surveys are being carried out and will also take additional time. The software for operations planning, which shows great promise, requires adjustment and will need time for further development and testing as data from MMIP becomes available. The same is true for the irrigation management information system. Recommendations on rotational water supply are underway but further studies are necessary.

Recommendations have been made by the Evaluation Team that the Agriculture and Irrigation Departments of GOM pay more attention to supporting and encouraging the implementation of water and land management practices. The installation of Part II practices and drainage measures were observed to be lacking. The current general stream of project information needs to be quantified by GOM/ID for future appraisal and expansion of MMIP concepts. It also needs to develop a minimal farm cost accounting system and a method to obtain information for crop budgets and price and input sensitivity analysis. USAID also needs to consider measures to provide project support for many of the worthwhile suggestions made by the 1987 evaluation team.

Conclusions

The early results of the MMIP are extremely encouraging. Relatively robust irrigation systems have been constructed and water user groups have been formed who express a confidence in their capacity to take over and operate and maintain the field channels and a willingness to consider managing and maintaining the

entire distribution system. The infrastructure has been created to operate these systems at efficiency levels unknown on minor irrigation systems. Preliminary evidence suggests application efficiencies as much as 100 percent greater than on MIS not under this project. Nine of the completed project schemes have reached 100% coverage of the planned irrigable command area during the first season that the full compliment of water was available from the reservoir. This is an outstanding achievement.

The outputs of the project are :

1. A system for constructing relatively robust minor irrigation systems capable of delivering water at design standards.

2. A system that promotes pride in the construction of MIS by the irrigation department and a confidence of the farmers in the capability of those systems

3. Functioning outlet committees and the beginnings of tank committees. The GOM/ID has issued an order which formally require water user associations on all MIS in the State of the type incorporated into the USAID/MMIP

4 A positive attitude in the GOM/ID concerning working directly with the cultivators on water distribution below the outlets.

5. The micro-computerization of many aspects of irrigation planning, design, daily operations and the management of the rotations on the MIS in the project.

6. A sense of ownership and pride on the part of the farmers in the irrigation system.

None of the individual components of the irrigation "package of practices" assembled under the MMIP is by itself sufficient to achieve the output potential inherent in the irrigation system.

However taken together, there is evidence that they may revolutionize water application efficiency and the net returns from investment in minor irrigation systems. There is the additional potential that this package can be transferred to medium and major schemes as well.

It is to be noted that in addition to its many successes, there is much that is not yet right with this Project. The deficiencies need to be corrected to capture the promise which has been created to date. A synopsis (two liners) of selected recommendations made by the Evaluation Team is attached as Annex I to this summary.

It is the opinion of the Evaluation Team that the entire MMIP program should be extended for a period of one year and that those technical assistance and information gathering components supported by grant funds should be extended for a full three years. A suitable method needs to be found for continuing these needed and beneficial activities. A summary of the rationale for extending the project as recommended follows:

1. Late approval (as late as 1988 to 90) for the implementation of many MIS and studies and pilot activities and other unforeseen complications have not left adequate time for their completion before the PACD. A few large MIS (over 1000 ha) will also require additional time for completion.

2. To determine the extent to which the successes that have been achieved so far can be held in place and if the next round of activities can be successfully achieved. In particular the capacity and willingness of the tank committees or water users associations to assume the duties of the repair and maintenance of the main canal an minors needs to be determined. A maintenance allocation that more reflects the relative burden to be assumed across the different MIS may be necessary.

3. To establish a methodology for extending the package of irrigation practices to the rehabilitation of existing systems

4. To develop procedures for incorporating the benchmark system into the construction of new irrigation facilities financed by GOI

5. To fine tune the computerized irrigation management information system and determine the most effective vehicle for incorporation this management method into the operation of existing MIS.

6. To develop, utilize and extend the capacity to distribute and manage water to include conjunctive use and environmentally sensitive field distribution techniques such as hand surge. This, along with the package of essential activities developed so far could establish a methodology for and describe the necessary conditions for investing in environmentally sustainable irrigation.

7. To develop, at the appropriate time, outreach materials for extending the package of irrigation practices developed in this project to other areas of India and around the world. This should include written materials and videos scripted and produced in part by international experts in water management who have had experience in this type of activity

In summary, although there is much that remains to be done, this evaluation believes that a truly innovate approach to irrigation development has evolved out of this project. Many stereotypes have been challenged and in their place is the promise of a "blue revolution".

SYNOPSIS OF RECOMMENDATIONS

MAHARASHTRA MINOR IRRIGATION PROJECT

A. PERFORMANCE BASED DISBURSEMENTS

It is recommended that

1. USAID employ the use of PBD where the primary purpose is to achieve improved performance. (see pages 21, 25)

2. USAID consider longer project performance times to consolidate full benefits from irrigation schemes. (see pages 22, 25)

3. GOM/ID evolve accounting system procedures for the use of performance Bench Marks in their program. (see pages 23, 24)

4. USAID grant MMIP an extension of an additional year to complete the construction of planned 90 MIS's. (see pages 22, 26)

B. STANDARDS AND PROCEDURES

It is recommended that

5. The standards and procedures methods adopted for MMIP should be widely publicized. (see pages 37, 38)

6. GOM continue studies on hydrological relationships for yields & peak floods and USAID extend their support. (see page 38)

7. GOM continue the silt studies, as more details are needed, and USAID extend their support. (see page 38)

C. PERFORMANCE TESTING

It is recommended that

8. GOM and USAID publicize widely the success of performance testing of irrigation delivery systems. (see pages 40, 44)

9. GOM use suitable precautions in dealing with likely staff problems due to performance testing. (see page 45)

D. INSTITUTIONAL DEVELOPMENT AND LINKAGES

It is recommended that

10. GOM/AD take earnest responsibility for MMIP extension work, developing suitable mechanisms for involvement. (see page 57)

11. GOM/AD take up pilot demonstrations and training for land shaping and soil conservation measures in MMIP. (see page 59)

12 GOM/AD explore methods to provide farm power and implements to farmers for land shaping. (see page 60)

13. GOM/AD adopt the concept of agricultural Bench Marks in implementation of agricultural development. (see pages 60, 65)

14. USAID support special activities for establishment of pilot demonstrations in selected chaks. (see pages 64, 65)

E. WATER USERS ASSOCIATIONS AND FARMER PARTICIPATION

It is recommended that

15. USAID extend MMIP support for farmer organizations for an additional three years. (see pages 74, 75, 77)

16. GOM/ID create a capacity to train additional manpower for full implementation of the Nov. 90 order on WUA's. (see page 77)

17. GOM/ID conduct pilot studies (possibly using NGO's) to organize water users associations. (see page 77

18. GOM/ID conduct pilot studies to evaluate the OC's capacity to handle water saving practices. (see page 77)

19. GOM/ID develop an outreach program to explain the total concept of MMIP to other irrigation agencies. (see page 77)

20. GOM/ID evaluate WUA capacity to manage system maintenance functions including conjunctive use. (see page 77)

F. ORGANIZATIONAL AND STAFF CAPABILITIES

It is recommended that

21. GOM/ID consider the continuation of some of the special cells & committees established under MMIP. (see pages 80 88)

22. GOM/AD&ID give more regard and attention to agricultural disciplines in cells such as SAEC & RMIC's. (see page 88)

23. GOM/AU's strengthen faculties of agricultural engineering & soil science in addition to agronomy. (see page 88)

24. GOM/USAID provide equivalent incentives to the AD & AUs for establishment of MIS models. (see page 88)

25. GOM/ID extend in-service problem oriented training facilities to AD & AUs in line with the staff of ID. (see page 89)

26. GOM/ID organize farmers training in land development and water application methods in each MIS. (see page 89)

G. COMPUTERIZED MANAGEMENT INFORMATION SYSTEM

It is recommended that

27. GOM/ID monitor & field test IMIS for at least another three years with USAID support. (see pages 94 98 99)

28. GOM/ID with USAID support continue to provide computer site service by specialists from LCU/USAID. (see page 92)

29. GOM/ID with USAID support introduce more sophisticated irrigation oriented software packages. (see pages 92 98 99)

30. GOM/ID and USAID provide training for more personnel on basic computer skills and software applications. (see pages 94 99)

31. USAID continue to provide the services of consultants who have developed the MI Model. (see page 99)

32. GOM/ID with USAID establish a system to evaluate successes & failures of IMIS by outside consultants. (see page 100)

H. WATER AND LAND MANAGEMENT PRACTICES

It is recommended that

33. GOM/ID with USAID provide wider adoption of computerized appraisal of evapotranspiration & crop use. (see page 108)

34. GOM/AD give due priority to establishment of demonstration chaks & develop a time-bound action plan. (see page 109)

35. GOM/ID review procedures adopted in diagnostic analysis i.e. farmers views on rehabilitation requirements. (see page 106)

I. PRODUCTION, INCOME, AND EMPLOYMENT GAINS

It is recommended that

36. GOM/ID document the additional benefit streams from the Minor Irrigation Schemes. (see pages 113 116)

37. GOM/ID establish procedures to better integrate economic information/analysis into supporting groups. (see page 114)

38. GOM/ID collect employment information for planning purposes. (see page 115)

39. GOM/ID incorporate a system of crop cost accounting within the IMIS. (see page 116)

40 GOM/AU's develop procedures to ensure that agricultural economists work more closely with other SMS. (see page 116)

41. GOM/ID ensure that the capability to incorporate conjunctive use management be built into IMIS. (see page 117)

J. FOLLOW-UP MEASURES

It is recommended that

42. GOM/ID with USAID support vigorously pursue ongoing follow-up actions & posthaste take up those as suggested. (see page 131)

MAHARASHTRA MINOR IRRIGATION PROJECT

FINAL EVALUATION

TABLE OF CONTENTS

ACRONYMS AND SPECIAL TERMS

AD/SC	Agriculture Dept., Soil Conservation Section
AD	Agriculture Department
ADB	Asian Development Bank and Land Management Institute
ASR	Appraisal Summary Report
AU	Agriculture University
BM	Bench Mark
CCA	Culturable Commanded Area
CCDC	Central Computor Development Committee
CHAK	Irrigation outlet unit
CTF	Cut Throat Flume
DIRD	Directorate of Irrigation Research & Development
EEC	European Economic community
ERR	Economic Rate of Return (ID) Pune
FAR	Fixed Amount Reimbursement
FSL	Full Supply Level
GCA	Gross Commanded Area
GOI	Government of India
GOM	Government of Maharashtra
GSDA	Groundwater Survey & Development Agency
GTS	Geographic Traverse Survey
ha	hectare
ICA	Irrigable Command Area Maharashtra
ID	Irrigation Department
IPWRIG	Irrigation Projects and Water Resources Irrigation Circle
Kharif	Crops grown in monsoon season
KKV	Konkan Krishi Vidyapeeth Dapoli (AU)
LCU	Liaison and Coordination Unit
m	meter
M	Million
MAD	Management Allowed Deficit

MDD	Maximum Dry Density
MIC	Minor Irrigation Committee
MIS	Minor Irrigation Scheme
MKV	Marathwada Krishi Vidyapeeth Parbhani
MMIP	Maharashtra Minor Irrigation Project
MPAU	Mahatma Phule Agriculture University, Rahuri
MWL	Maximum Water Level
NGO	Non Government Organisation
OC	Outlet Committee
OMC	Optimum Moisture Content
PACD	Project Agreement Completion Date
PAP	Project Affected People
PBD	Performance Based Disbursement
PIP	Pre-season Irrigation Plan
PKV	Punjabrao Krishi Vidyapeeth Akola (AU) followed in N.W. India
PMF	Project Maximum Flood
PP	Project Paper (USAID)
Rabi	Crops grown in winter season
RMIC	Regional Minor Irrigation Cell
RWS	Rotational Water Supply
SAEC	Special Analysis & Evaluation Cell
SASC	Special Appraisal and Supervision Cell
SDAO	Sub Divisional Agriculture Officer
Shejpali	Water allocation system by rotation being
SMS	Subject Matter Specialist
SWF	Standing Wave Flume
T&V	Training & Visit system of AD
TMC	Tank Management Committee
USAID/AID	United States Agency for International Development
USD	United States Dollar
VEW	Village Extension Worker
Warabandi	Water Allocation System by rotation being WALMI
Water WB	World Bank
WUA	Water Users' Association

FINAL EVALUATION

MAHARASHTRA MINOR IRRIGATION PROJECT (MMIP)

I. INTRODUCTION

This final evaluation of the Maharashtra Minor Irrigation Project, assisted by the United States Agency for International Development (USAID), addresses the conduct of the project in meeting its designated goals for 90 Minor Irrigation Schemes (MIS) and allied studies, pilot projects, and institutional strengthening measures in the State of Maharashtra. It analyzes its successes and failures and the problems that have been encountered. Eleven critical project issues have been evaluated in detail. It has as its fundamental purpose the assessment, to the extent possible, of the impact that the project has on the irrigation sector in Maharashtra

The purpose of the MMIP is to increase irrigation efficiency by improving management and physical infrastructure of minor irrigation systems and by improving the distribution, application and utilization of water below the public outlet. The goal of the project is to increase food production and rural employment in India and in Maharashtra in particular. It is a goal of the Irrigation Department (ID) in the Governmant of Maharashtra (GOM) to improve the quality of irrigation within the State as well as to expand the area of lands that are irrigated.

Irrigation is a critical factor in India's agriculture and rural economy. The population now stands at over 800 million (M) and is growing at the rate of about 15 M more each year. Very little additional land can be brought under cultivation and increases in production will have to come from increasing cropping intensities and yields which depend predominantly on reliable water supplies. Projections in the Government of India

(GOI), therefore, call for even greater dependence in the future on irrigation sector to generate both income and employment on a fairly sustainable basis.

There is considerable scope in the State of Maharashtra for the improvement of agricultural production and for enlarging the area of irrigated lands. At the time of preparation of the Project Paper (PP) of the MMIP, there were 22.7 M ha of cultivated land in the State of which 1.9 M ha or about 8% was irrigated. It has been estimated that there is a potential to increase as much as 7 or even 8 M ha of the arable land under irrigation from surface and ground water development.

The GOM/ID is generally considered to be one of the strongest in India. They, of course, are always looking for new and better ways to improve irrigation operations in Maharashtra. High ranking officers and staff alike have cooperated fully in the administration and implementation of the MMIP and recognize the benefits and support the innovative developmental undertakings that are being introduced on this project. They also understand that the excellence of implementation of irrigation measures for MIS's has often been somewhat overlooked in partiality to the larger and more technically fascinating Major and Medium Projects.

As its name implies, the MMIP involves the implementation of improved institutional and physical practices on small irrigation schemes. MIS's are projects which irrigate 2000 ha or less. The schemes included in MMIP have irrigation command areas (ICA) ranging from 102 to 1615 ha in size with an average project ICA of 294 ha. MIS's are unique in that they tend to occur in remote areas of the upper reaches of the watershed where land conditions for irrigation are generally poor and water availability is limited. The beneficiaries also are inclined to be in the lower range of the socio-economic structure. Minor schemes, however,

take much less time to construct and deliver water to the beneficiaries than do the larger Medium and Major schemes. They do not give rise to any major environmental problems as compared to larger projects.

II. BACKGROUND

The Maharashtra Minor Irrigation Project was initiated on July 31, 1985 when the Project Loan and Grant Agreement between GOI the US Government was signed. The purpose of the project, at that time, was to assist GOM in the construction of 90 new schemes; the rehabilitation of 12 existing minor irrigation schemes; the establishment of 52 hydrological stations; the training and development of 1805 ID staff; the functioning of two demonstration chaks per scheme; the taking up of nine studies, 12 diagnostic analyses, four baseline surveys and eight basic pilot activities; and the conducting of activities to ensure participation and involvement of farmers in determining layouts of water distribution systems of tank based minor irrigation projects. This Original Agreement was amended on March 12, 1985 to lend remaining additional Loan and Grant funds to increase the funding to the full amount of $50 M.

A. PROJECT COMPONENTS

The project components of MMIP can be categorized in four primary groups as follows:

(1) Studies and Pilot Activities
   (a) improvements in basic data collection and analyses procedures
   (b) development and use of a computerized minor irrigation model.
   (c) diagnostic analysis of 12 existing minor schemes

to be renovated.

(d) pilot investigations for analysis and demonstration of new planning, design, and management ideas.

(2) Institutional Support and Development.

(a) Institutional Reorganization

(i) Minor Irrigation Committee (MIC)

(ii) Special Appraisal and Supervision Cell (SASC)

(iii) Special Analysis and Evaluation Cell (SAEC)

(iv) Regional Minor Irrigation Cell (RMIC).

b. Conduct 15 Types of Institutional Training Courses

c. Establish a Computer Data Management Program.

(3) Construction of 90 New MIS's and Renovation of 12 Existing Schemes.

(4) Support for State-wide Hydrologic Data Base Improvement.

B. PROJECT HISTORY OF MMIP

During the life of MMIP there have been a number of changes including omissions and additions to the project components. The MMIP started rather slowly with either commencement or acceleration of existing planning and design procedures. The approval of minor schemes for official inclusion in MMIP occurred at the same time and the first batch of projects were not sanctioned until February of 1986. Other larger batches followed in the months of March and December of the same year. The first MIS scheme to reach the second level of performance was in October of 1987 with a large number meeting these requirements in 1988. At this point in the project it was clear that the Project Assistance Completion Date (PACD) of September 30, 1990 would be difficult for most of the schemes to achieve. In fact, only

three of the 90 projects met this deadline. In 1990 a request for a two year extension of the MMIP was submitted by GOI/GOM to USAID. Due consideration was given to this request and an extension of one year was granted. A number of time extensions for studies and pilot activities have also been granted over the course of the project with most being extended to the current PACD.

A listing of some of the alterations to the make-up of MMIP is as follows:

- o Addition of performance testing to BM conditions as a means to verify the complience of the delivery system to required criteria and conditions.
- o Change of disbursement percentage allowances for various stages of project performance.
- o Emergence of computerization as a major project component.
- o Deletion of catchment area treatment study.
- o Deletion of the rehabilitation of 12 existing MIS schemes.
- o Addition of three supplemental benchmarks (SBM).
- o Change in agriculture support to MMIP from Agriculture Department to Agriculture Universities in most (67) of the schemes

C. CURRENT STATUS OF THE PROJECT

The MMIP has established itself as an excellent example of how innovative development assistance can be extended to small irrigation schemes in India. Although one extension of one year has been given to MMIP (a two year extension was requested) and most of the project components are nearing fruition they will not, for the most part, be completed by September 30, 1991. It

is estimated that an another year (this will allow an additional construction season) will be needed to complete most of the active MIS's and that an additional two years (three years total) is needed for the institutional development components to accomplish their intended objective.

The following is a summary of the current status of reportable MMIP components as they stood at the time of this evaluation
mission. A more complete presentation of these accomplishments can be seen at Annexure V.

1. STUDIES AND PILOT ACTIVITIES

a. Special Studies

Out of nine approved studies five have been completed and four are still ongoing. (See Annexure V-1 for further details.)

b. Diagnostic Analysis

The 12 diagnostic analysis studies of the MIS projects to be rehabilitated were completed. The results of these combined analyses were, in fact, the basis for the discontinuance of the rehabilitation of existing MIS's component of this project.

c. Pilot Activities

Of the eight planned Pilot activities, seven were approved and one was discontinued after planning operations revealed that excessive costs would be encountered. All of the approved Pilots are currently ongoing and are expected to be completed by the revised PACD. (See Annexure V-2 for additional information.)

2. INSTITUTIONAL DEVELOPMENT

a. Institutional Reorganization

Three new GOM/ID organizations have been created and one has been reorganized to comply with project requirements. These organizations have been discussed in detail in Section IV.F "Organizational and Staff Capabilities".

b. Training Courses

Approval has been given to 14 types of training in which 1867 individuals have received instruction in water management, improvement of irrigation practices and other related subjects. (See Annexure V-3 for further details of training activities.) Additional training is planned but the time for completing them within the current framework of MMIP is growing short. 2700 farmers are planned to be trained but the time for this training to take place is after they have delivery of water from the completed scheme. Attainment of much of this training with USAID assistance will require an extension of project time or some other type of coverage.

c. Computer Data Management Program

This project component under the responsibility of the SAEC and with active assistance from the Liaison and Coordination Unit (LCU) and other USAID implementation assistance has developed a number of computer programs which it is in the process of perfecting. Programs for a (i) hydrological data base management system, (ii) irrigation management information system, (iii) minor irrigation database management, and (iv) the highly regarded MI MODEL for the use in scheduling irrigation in

accordance with soil and plant water use requirements have been created. Preparation of other computer management programs are currently being considered.

3. CONSTRUCTION & REHABILITATION OF MINOR SCHEMES

a. Construction of New MIS's

All the 90 planned new MIS have been approved for USAID assistance and all have qualified for advancement of loan funds for carrying-out the first two of the four performance benchmarks. These performance benchmarks are explained in Section V.2 of this report. The third performance stage, which requires, among other things, completion of 75% of the irrigation and drainage system has been passed by 59 MIS's. Completion of the scheme in so far as construction activities are concerned is denoted by the fourth benchmark and this final goal has been accomplished, as of June 17, 1991, by 28 of the 90 approved MIS's. Details of these achievements are summarized in Annexure V-5 and can be further scrutinized by examination of Annexure V-6 through V-11 which give details for each MIS project on a Regionwise basis.

b. Rehabilitation of Existing MIS's

As stated above the planned program for the rehabilitation of the 12 existing minor schemes was abandoned for economic reasons. The cancellation of this project component has been recognized by USAID in the Project Implementation Letter (PIL) No. 52.

4. ESTABLISHMENT OF HYDRO-METEOROLOGICAL STATIONS

The construction of 52 hydro-meteorological stations as approved under the MMIP is underway. 30 type A and 22 type B stations were approved. At this reporting, 17 type A stations and 15 type B station have been completed. (Further details regarding the installation of these hydro-meteorological station may be seen at Annexure V-4.)

5. SUPPLEMENTAL BENCH MARKS

Supplemental Bench Marks (SDM) were proposed for the MMIP early in 1991 when it became apparent that come of the project components such as "catchment area treatment pilot" and "rehabilitation of existing schemes" were not feasible for completion within the PACD of September 30, 1991. It was decided to program the uncommitted funds for the purpose of institutional actions related to the formation and effective functioning of Water User's Associations and the adoption of improved design criteria developed under the subject project to the entire Minor Irrigation Sector in Maharashtra. The use of SBM's was authorized under PIL No. 52 dated February 12, 1991 which contains the following criteria:

SBM I - Farmer Organization/Water User's Association: GOM/ID supporting formation of WUAs to participate in O & M procedures and ultimately handing over the MIS to farmer community for O & M.

SBM II - Adoption of Project Design Criteria: As developed & adopted under the project in the entire Minor Irrigation Sector.

SBM III - Adoption of Performance and Operation Testing Procedures: In the entire Minor Irrigation Sector. This SBM also includes the creation of a unit/cell in each of the six Regions in X for assisting and monitoring the implementation.

III. OBJECTIVES

A. GENERAL

The primary objective of this final evaluation was to review and assess the effectiveness of increasing the efficiency of irrigation in Maharashtra and the results and probable sustainability of the measures that were introduced through the USAID assisted Maharashtra Minor Irrigation Project. In pursuance of this mission the Evaluation Team concentrated on eleven critical issues that were considered as the key elements of this project. Of additional concern was the extent to which the goals of MMIP had been achieved and the problems that were encountered along the way. The Team's Statement of Work (SOW) is included as Annexure I

B. REVIEW AND FIELD VISITS

In order to achieve these objectives the Team reviewed most of the available data as listed in the SOW and other pertinent materials as they became available. The Team spent two weeks, between June 17 and 30, 1991 in Maharashtra visiting field sites and holding discussions with officials of the Irrigation Department and other related institutions in Bombay, Pune, Aurangabad, and Nagpur. The itinerary followed by the Team during this mission is shown as Annexure III. A list of the officials and farmers visited is contained in Annexure II.

During their field visits the Team was able to spend time on

11 different MIS projects and was able to collect a wealth of valuable and relevant information from actual field conditions. Discussions with field staff from the ID, Agricultural Universities, and the AD as well as with many farmers were held during these site visits and proved to be extremely interesting. These MIS sites were situated in the Aurangabad, Pune, Amravati, and Nagpur Regions of Maharashtra. At these locations the MIS dam and reservoir, the canal distribution system, and the conditions in the chak were observed. Attention was also paid to have audiences with as many farmers as possible. A brief synopsis of each of the visits is contained in Annexure IV.

C. THE EVALUATION ISSUES

The key evaluation issues addressed by the Team are extremely important to the overall performance of MMIP. They are all closely related to better water management practices and the improvement of irrigation efficiencies in Maharashtra. The discussions of these critical points are contained in Section IV, "Evaluation Issues", and make up the main body of the report. They are briefly listed below.

(a) Performance based disbursement (PBD) system and its efficacy and adaptability.

(b) Standards and procedures used for ensuring progress and quality of construction work.

(c) Performance testing procedures developed to ensure reliability and dependability of irrigation systems created under the project and its adoption and replicability.

(d) Institutional development changes in GOM's perception,

practices and understandings in relation to minor irrigation sector and linkages among irrigation and agriculture departments and agricultural universities forged during the project

(e) Water users associations and farmers participation in determining layout of channels and water courses and assuming responsibility for operation, maintenance and management of irrigation systems.

(f) Organizational and staff capabilities created and developed for better project implementation and management.

(g) Computerized IMIS and its use for demand aggregation, scheduling, billing and accounting.

(h) Water and land management practices and policy options selected on the basis of data from hydrological stations, demonstration chaks, special studies, pilot activities and diagnostic analyses.

(i) Production, income and employment gains from the water and land management practices and efficient irrigation systems created. (to the extent possible)

(j) Follow-up measures taken after evaluations and improvements achieved during the project.

Each of the sections written on the above topics contains a discussion of the evaluation issue followed by the conclusions and recommendations of the Evaluation Team. The discussion of these issues are presented individually in Section IV, which follows, and constitute the main body of this report.

D. RECORD OF LESSONS LEARNED

An important objective of this evaluation of the MMIP was for the Team to identify and record their assessment of the lessons that have been learned on this project. These lessons have been combined into one presentation which are contained in Section V of the report.

IV. EVALUATION ISSUES

The ten major issues selected for evaluation are contained as seperate divisions of this section of the report. As a whole they make up the principal body of the "Final Evaluation Report" for the USAID assisted MMIP. Each issue division contains an introduction, background of factors for which the evaluation is made, observations and findings of the Evaluation Team, problems encountered, and conclusions and recommendations regarding the individule issue. The evaluation of these issues is contained on the following pages.

A. RERFORMANCE-BASED DISBURSEMENT (PBD)

1. INTRODUCTION

The primary objective of the Maharashtra Minor Irrigation Project is to increase irrigation efficiency by improving the management and physical infrastructure of irrigation systems and by improving the distribution, application and utilization of water below the public outlet. In past irrigation projects, USAID has used some form of fixed amount reimbursement (FAR) to disburse against completed construction projects. The objective of MMIP is not purely construction but rather institutional development and improved irrigation performance. Therefore, instead of using the traditional FAR method, a system of disbursement based on realization of the performance of project goals has been adopted. PBD focuses on performance of a better quality of project planning and design, a more effective water delivery system, and improved use of irrigation water below the public outlet.

2. BACKGROUND

A policy of USAID assistance funds based on the identifiable performance characteristics of the project was introduced for the first time in India on the MMIP. Indicators of performance on which disbursements are made were divided into four major groupings and identified as Bench Marks (BM) the requirements of which were derived from the "Summary of Criteria and Conditions for Approval of Sub-projects" as listed in Annexure B-1 to the MMIP Project Paper. These conditions as used for the individule BM's is contained as Annexure A-1 to this report. These conditions and criteria were chronologically selected for inclusion in one of the four performance BM's.

a. Classification of Bench Marks

The four performance based BM's are briefly classified in regard to basic performance requirements as follows:

Bench Mark I: Scheme planned/designed by Regional Circle, appraised by Special Appraisal and Supervision Cell and approved by Minor Irrigation Committee and concurred to by USAID.

Bench Mark II: Design completed for distribution system and Part I works supported by detailed layout maps of the command area and soil survey reports . Farmers participate in determining layout of channels below the outlet and accept final plan.

Bench Mark III: Completion of the headworks, 75% of irrigation and drainage system, and 30% of Part I works of the command area. Completion of land acquisition for distribution system duly supported by GOM reports. Performance testing of the completed portion of the distribution system is also required.

Bench Mark IV: Completion of the remaining 25% of irrigation and drainage system, remaining 70% of Part I works, resettlement of displaced land owners and organization of outlet committees in at least half of command area. Operational testing for satisfactory performance for the entire distribution system to the farmers field is specified.

b. Objectives of Bench Marks

The purpose of BM-I is to provide an initial early-on payment for pre-construction work performed by GOM on Minor Irrigation Schemes. This is established by allowing disbursement of an advance of 22.5% of the USAID contribution for improved and accepted planning/design of the schemes.

Bench Mark II guards against faulty construction of the distribution system due to inadequate design and provides for farmer participation in the layout of field channels. For approved completion of these a advance of 15% of the USAID contribution can be authorized.

Acceleration of construction of the distribution system to more closely coincide with the completion of the headworks, initiation of Part I works (irrigation and drainage measures within the chak) and completion of land acquisition is promoted by B.M. III. Upon completion and successful testing of the distribution system to 75% of the command area, implementation of 30% of the Part I works and acquisition of all land for the distribution system, an advance of 37.5% of the USAID portion of eligible scheme costs will be distributed.

Bench Mark IV encourages the speedy completion of the entire scheme and the establishment of outlet committees to assure that the scheme is effectively utilized. Successful operational testing of the distribution system is required to ensure acceptable water delivery. For this purpose the final 25% of the USAID contribution can be disbursed and with the previously advanced 75% of the eligible costs constitute full disbursement of the previously established Fixed Cost for the project component. (See the provisions of PIL No 4 dated Jan. 15, 1986 for further details regarding the repayment of advanced funds.)

3. OBSERVATIONS AND FINDINGS

The evaluation of PBD is based on the achievement of these intended goals, the suitability and effectiveness of this Bench Mark system for the purpose of disbursement of funds and the degree of acceptability by GOM. Reports are prepared for each of the Bench Mark stages with the assistance of SAEC and the LCU. Many of these benchmark reports were examined by the evaluation team for a number of MIS's. A brief summary of the observations and findings by the evaluation team on each of the performance benchmarks follows:

a. Bench Mark I

Improved planning reports, called Appraisal Reports, prepared for BM-I were found to contain complete information on the physical features of the project area, the fundamentals of project design and an economic analysis. Complete listings of available data rainfall, agro-meteorological factors, soils, crops, irrigation requirements and other pertinent facts are also contained in this document.

b. Bench Mark II

A "Chak Layout and Design" report is prepared for BM-II and includes a design report and a map (1:4000 with 1 m contours) showing the layout of the chaks with irrigation and drainage measures, a typical chak map (1:1000 with 0.2 m contours), and 'L' Sections of the Main Canal and for the indicated Field Channel. A list indicating the consent of the Villagers is also included.

c. Bench Mark III

In the report for BM-III it is certified that the headworks are complete, 75% of the irrigation and drainage system is

completed, 30% of Part I works is complete, and that the lands required for the distribution system have been acquired. A map and a dot chart showing the works completed is included and a report of the Performance Test is also attached.

d. Bench Mark IV

Preparation of the BM-IV report signifies the completion of the MIS. This report contains complete information on the scheme, an operations plan, results of the Operations Test of the complete distribution system, and a list of documents handed over to the Management Wing. Also included are a list of Outlet Committees (OC) with rules and a sample certificate for transfer of Part I works handed over to them. A verified Certificate of Completion and a check list of all requirements of compliance are incorporated in this document.

e. Approval of Bench Mark Reports

Each level of performance completed on a MIS is chronicled by a benchmark report. Many of these documents were reviewed and found to be well prepared and containing complete information on performance requirements. They were noted to be duly verified as meeting all of the requirements of the particular BM by the RMIC and SASC or SAEC. These BM reports were reviewed and approved by USAID before reimbursement was made for meeting the benchmark requirements.

f. Format of the Reports

It was further noted that these BM documents all followed a prescribed and comprehensive format assuring that all of the pertinent information required was included. These "level of performance" reports are professionally published and bound in hard

back covers. Assistance for preparation of formats for uniformity and completeness of reporting for the benchmark system and in presentation was received from both the LCU and SAEC.

g. Achievements of PBD

Review of the above benchmark reports and confirmation through field visits to a number of MIS locations (see Appendix IV) was essential to the evaluation of the appropriateness of PBD. Through this method of analysis, the Evaluation Team was assured that the following MMIP goals were being achieved:

(i) Improved planning and design of MIS's is being carried out. Review of many BM-I and BM-II reports and on-site inspection in the field indicated that efforts are being made to thoroughly plan and provide complete and correct design measures.

(ii) Planning and layout of Part I works is being initiated at an early stage of the project. During the course of visits to MMIP schemes, the team was assured by ID officers and farmers alike that these works had been laid out prior to completion of BM-II requirements which occurs on an average about two and one half years before completion of the project. (See Annexures V-5 to 11)

(iii) The farmers are taking part in the planning of the Chak. On all of the schemes visited the evaluation Team talked to farmers and was assured by them of their participation in the layout of Part I measures.

(iv) Construction of the irrigation system has been markedly improved. Experience of the evaluation team and discussions with officers of the ID, and field inspections indicate that construction of the irrigation distribution system has been improved for those MIS's visited.

(v) Part I works are initiated earlier in the period of construction of the project. Part I works are initiated under BM-III requirements of 30% completion. Queries of farmers by team members indicate that this has been accomplished for MIS's completing BM-III, thus facilitating the completion of Part I works prior to the schemes first irrigation period.

(vi) There is an definite increase in the irrigated area of command in the first years of water delivery. Figures provided to the team show that a major portion of the planned irrigation did take place on most of the MMIP schemes on the first year while the amount normally irrigated on the first year of other other State sector minor schemes is much less. This is borne out in the table below.

Comparison of Initial Water Use in MMIP and Non MMIP Schemes
(Amravati District, Amravati Region, Maharashtra)

Item	Non MMIP		MMIP	
	Berda Tank	Salai Tank	Gambheri Tank	Jutpani Tank
ICA in ha	148	277	220	175
Actual Irrigation Accomplished in ha (Rabi)				
Year of Irrig.				
First	3	28	5	19
Second	25	52	35	63
Third	37	39	87	90
Area Irrigated in ha per Mcft (Rabi)				
Year of Irrig.				
First	0.23	0.79	1.10	2.00
Second	0.78	1.46	1.67	2.45
Third	1.27	2.05	2.21	3.27

(vii) Land acquisition for the distribution system is cleared early in nearly all MMIP schemes to avoid delays in project completion. Certificates of compliance with this BM requirement were examined by team members and discussions with farmers during the field visits confirmed that these acquisitions had been obtained.

(viii) The final completion of MMIP projects is accelerated. The overall time to complete the 90 MIS projects in MMIP has not come up to the original expectations of the planners. However, the time to finish the final step of the PBD program has been expedited. The average time period between approvals BM's-III and IV as shown by examination of Annexures V-(5 to 11) is only about 10 months.

The above indicators represent the achievement of project goals. These targets are incorporated as performance requirements of the Bench Mark system. They clearly indicate that the use of PBD has been effective in promoting the accomplishment of most of objectives of the project.

h. Acceptance of PBD Method

The performance-based distribution system is widely accepted by the GOM officers who have been associated with this method for the past five years. Most of these staff members queried have been involved, in one way or another, with fixed amount reimbursement and find PBD to be a much preferred procedure. USAID officers involved with MMIP also felt that it was a better method of disbursement of funds for the assistance to this project. The mid-term evaluation (Keller Report) also praised the use of performance oriented disbursement on MMIP.

4. PROBLEMS ENCOUNTERED WITH PBD

Few problems have been encountered with the actual administration and execution of the PBD program. There were some initial adjustment difficulties in organization and coordination for a new system and, of course, there have been the usual problems associated with meeting time requirements of performance deadlines. Sustainability of this popular method of fund disbursement, after completion of project assistance without donor funds, is also of concern. The imbalance of the proportionate share of project cost to that originally planned was the most apparent problem for GOM. Four problem areas that warrant further mention are discussed in the following sections.

a. Completion of Projects

Admittedly, the overall period of construction of USAID minor schemes has not been as rapid as the MMIP planners envisaged. But, this may be due to higher performance expectations by the planners than the existing "system" has been able to assimilate. Assuming that the elapsed time between approval of the MI Schemes for BM-I (PIL Date) and the approval of BM-IV (Completion document) is a gage of the time period of construction of the project, then the average time for completion now stands at 59 months or almost 5 years. This compares to about 4 years as originally thought. This figure for the MIS construction can only increase as additional time is used to complete the unfinished schemes.

b. Reduced Project Support

All of the higher level GOM/ID officials visited by the Team expressed their dissatisfaction with the reduced level of fiscal support being received from USAID for MMIP, for which eligible costs were fixed in Rupees (Rs) based on original cost estimates.

These estimated project costs were approved for each of the 90 USAID assisted schemes at the time of the PIL sanctioning the achievement for BM-I (Planning). The USAID share at this time was to be 67 percent of the eligible costs (basically total costs less land acquisition costs). This disbursement cost was then fixed in Rs. Over time, the construction costs of the MI schemes for GOM/ID have increased appreciably (much more than planned inflation factors allowed) and the value of the Rupee has diminished with respect to the USD (more than double in the past six years). This has resulted USAID's proportionate share of the overall cost at the present time is about 33% rather than 67% as originally concurred. As the value of the Rupee with respect to the USD has decreased about double, this means that USAID is assisting at the rate of one half of the original level with "out-of-pocket" USD expences also at about one half of planned amount.

If the eligible costs for disbursement had been fixed in US dollars (USD) rather than in Rs, in this instance, the increased ruppee disbursements would have kept pace with increased construction costs. However, many other scenarios with these fiscal variables are possible. Therefore, the Evaluation Team felt that it would not be prudent to make any recommendations on this basis and let the conditions as reported stand on their own merit.

c. Sustainability of PBD

Although reimbursements on the basis of performance was highly thought of by all concerned for the purpose of disbursement of donor funds, most felt that it would have little value in the normal GOM procedures. The absence of outside assistance to the irrigation program removes much of the incentive for meeting the bench mark criteria. This performance based system has been effective in promoting improved irrigation practices, increased irrigation efficiencies, and expanded participation by the farmers

in project management. Therefore, methods by which it can be implemented, to the extent possible, in the traditional management system should be explored by GOM/ID .

5. CONCLUSIONS AND RECOMMENDATIONS

The policy of disbursement of USAID assistance funds by means of accomplishment of specified levels of performance of project components (PBD) has been well received by GOM and the administration of this system of fund disbursement has been highly acceptable to USAID. The basic premiss of the use of PBD can be, therefore, considered as successful!

The MMIP procedures developed for PBD will not have an appreciable influence on the irrigation sector in Maharashtra, other than the part it played in improved operating efficiencies of the 90 schemes, unless they can be adapted in a revised form by GOM/ID for use in their normal programs. If so, then the use of these principles would facilitate a more balanced and rapid completion of irrigation facilities, Part I works, and formation of farmer organizations if used for these purposes. This would contribute to the improved water management and increased irrigation efficiencies in the State of Maharashtra.

Performance oriented goals were used in MMIP to achieve Project objectives through requirements for entitlement of donor funds for specified performance stages. Sustainability of this type of motivation would require alteration in order to be introduced into the regular GOM/ID program. However, this can be accomplished successfully as is being demonstrated, in part, by the Superintending Engineer on 30 Minor Irrigation Projects in the Amravati Region of Maharashtra.

Examination of the BM accomplishment dates for PBD reveals that more than one third of the schemes were not approved for MMIP until after February 1987 (with some as late as September 1988) and

that it requires, on the average, four and one half years or more to complete the scheme after that time. This leads to the conclusion that MMIP needs to be extended beyond the current PACD of September 31, 1991 for these worthwhile schemes to be completed with the support of USAID.

The above conclusions regarding performance based disbursement and the information as assimilated by the evaluation team during the course of briefings and field visits lead to the following recommendations directed toward either USAID or to GOM/ID.

It is recommended that:

(a) USAID employ the use of PBD on future projects where the primary purpose of the project is to achieve improved performance, i.e. by improving the management and physical infrastructure of irrigation systems and by improving the distribution, application, and utilization of water below the public outlet as in MMIP.

(b) USAID take into consideration, on future irrigation projects such as MMIP, that all project works can not begin on the first day of the project and accordingly allow for a longer period of performance time. This need to allow for ample time for planning and for the staggering of project starts over a reasonable period. Another reason for allowing increased time is to allow associated project components such as studies, demonstrations, training activities, and improved irrigation practices which need period of use interval after completion to be properly assimilated into the activities of the project.

(c) GOM evaluate the use of a modified form of the Bench Mark system for the purpose achieving improved irrigation and more efficient water use. Although the absence of the incentive or donor funds will eliminate some of the effectiveness of this system, it can be a beneficial method for improving the implementation and efficiency of irrigation projects. Encouraging more rapid completion of the distribution system and Part I implementation, increased farmer participation in the chak development, performance testing for improved performance of the conveyance channels and public outlets, and the timely formation of outlet committees are examples of benefits that could be achieved through use of this method by GOM/ID.

(d) USAID grant an extension of time of one year for Loan funds to adequately complete those MIS's that were either started late or are large (over 1000 ha) and have not had sufficient time for completion.

B. STANDARDS AND PROCEDURES

1. INTRODUCTION

The Maharashtra Government Irrigation Department has been undertaking works on all sizes of irrigation projects for a long time and has detailed manuals on designs as well as quality control of such works. The professional staff at all levels has considerable experience of carrying out these works according to existing standards. Apparently due to the minor irrigation sector consisting of smaller sizes of dams and canals, the senior level examination of designs and attention needed during cons-truction was not readily available almost all over the country. As a result of departmental pre-occupation with major and medium projects, the development of irrigation on minor projects has either not been achieving its full potential or was taking too long a period. In order to eliminate this short-coming, the USAID and GOM agreed to prescribe criteria for approval of sub-projects and procedure to be followed up to their successful completion.

2. STANDARDS

It was agreed that for all designs, the Manual of Minor Irrigation works issued by the GOM in 1983, as well as standards prescribed by the Indian Standards Institution be followed in MMIP. All the same, a set of criteria and conditions to be fulfilled for approval of each sub-project was agreed to and included in the PIL, as Attachment "A". A copy of these criteria and conditions is enclosed as Annexure B-1.

This provides for hydrology of the catchment-area, dam design, crop water requirement based on climatological data, conveyance system, delivery system,rotational delivery schedules, measuring devices, drainage, and acceptable ERR. During the course of the program, the USAID officers in close consultation with the ID officers of GOM evolved detailed criteria for different components of the sub-projects which are being followed. These are broadly described below.

a. Headwords

(1) Hydrology

Although there is data available on a very large number of dams for inflows and peak floods with the ID for considerably long periods, it has not been analysed to establish a corelation and old empirical formulas are being used. A study was started under this project which is continuing. Till availability of results from these studies, the yields and Peak floods are being worked out on basis of old formulas and wherever possible these are being cross-checked with records of adjacent catchment areas. The storage capacity is being designed on 50% to 75% dependability. The evaluation team however found that in many cases, the storage capacity of reservoirs has been limited for submergence considerations thereby reducing the irrigable command but improving the dependability.

(2) Reservoir Sill Level

Designs, thus far, were being done on an empirical formula which also presumed that the entire silt deposition took place in the dead storage area. A special study was undertaken on existing tanks under MMIP. Based on this study, the GOM has revised its criteria raising the silt expectancy by close to four times the earlier assumptions and distributing it equally in dead and live

storage areas. The sub-projects are now being designed on these revised figures taking a more rational life of the reservoir as well as progressive reduction in live storage availability.

(3) Earth Dam

The availability of suitable earth is being verified and earthen sections are being checked on basis of soil parameters. The maximum dry densities and optimum moisture contents of the soils are determined by laboratory tests and earth work is being compacted so as to attain not less than 95% of the MDD with a permissible variation of 2% in the OMC. Placement densities are being checked by taking a minimum of two tests for every 300 M^3 of earth work laid.

(4) Masonary/Concrete Structures

Structures are being designed in accordance with prescribed manual and cement is required to be tested before use. The sand used is also being checked for its Fineness Modulus. In addition mortar cubes are taken once in a fortnight and these are tested in laboratory at prescribed intervals. Water Cement ratio is maintained while preparing mortar/concrete mixes.

(5) Head Regulator

Well type regulators have been provided with a sturdy gate and its operation system. Automatic Stage water level recorders are being provided in the operation chamber to accurately calculate day to day inflows and outflows and also the floods. The operation chamber has been provided with a rolling shutter for safety.

(6) Stone Pitching

The upstream slope has been provided with pitching over quarry spauls upto MWL and has sufficient roughness to dampen wave action.

(7) Down Stream Drainage

Filter toe with toe drains and V-notches have been provided to safely dispose of seepage water and maintain record of the same.

(8) General

A minimum of two permanent Bench Marks connected to G.T.S. have been established and dam profiles, levels, widths of hearting and casing are being regularly checked during construction to ensure that they conform to the design.

(9) Rehabilitation

Adequate compensation has been paid to oustees. Most of PAP (Project Affected People) have lands on higher levels and lifting of water is being permitted to such of them as apply for the same. There were cases of some PAPs being rendered landless. On a few sub-projects such persons were being employed by the ID on their works. A uniform policy for this did not seem to exist.

b. Canal

(1) Crop Water Requirements

Cropping patterns are being worked out in consultation with the AU/AD and farmers before finalisation at Bench Mark II stage. Crop water requirements are being calculated after taking climatological data and the soil classification into consideration. A detailed soil survey has been conducted for the entire command of each sub-project.

(2) Draw Off Statement

This statement is being prepared after taking the following factors into consideration.

(i) Chak sizes have been limited to 25 Ha. Due to undulating nature of MIS commanded areas. These are normally of smaller sizes.

(ii) Each outlet has been designed to draw 30 litres per second with a minimum of 15 cms head over each point under command.

(iii) Withdrawals are being calculated from tail of the system to work out maximum requirement for the system.

(3) Canal Design

The distribution system is being designed for the draw off statement prepared as per item (ii) above with precautions as under:

(i) Reaches anticipated to have high rates of seepage or found to be seeping in the trial run/performance test are being lined. Very heavy seepage reaches have been provided with LDPE films below lining.

(ii) Cross-drainage works duly designed for adequate floods are being provided.

(iii) Road crossings, wherever necessary, are being provided.

(iv) Falls and regulators are being provided as per design manual. Additional approach lining and/or downstream protection have been provided wherever trial

run/performance test indicated this necessity.

(v) Regulators to enable outlets to draw full discharge at 50% of full supply discharge have been provided.

(vi) SWFs or CTFs have been provided at head of the canal, at each offtaking minor and along the conveyance system to be able to accurately know discharges at all important points of the system.

(vii) The canal system so designed and laid out on basis of topographical maps is discussed by the ID officers with farmers and their broad consent taken before the B.M.II stage.

(viii) The canal system has been laid out for balanced cutting and filling as far as practicable.

(4) Field Delivery System

Water courses/field channels for each chak are being constructed at project cost. Each field channel is designed for a fixed discharge of 30lps throughout its length with a cut-throat flume fixed close to the head. Falls, turnouts, cart-track crossings, Division-boxes etc. have been provided as per individual requirements. The field channel alignment has been finalised with full consultation of farmers and provides for a turnout for each farmer. Lining or dry stone pitching has been done in vulnerable reaches. Out of tanks visited by the Evaluation Team, turnouts/division boxes had steel gates in two of the regions and in one region these were proposed to be closed locally by earth plugs. It was found that one of the regions was using pre-cast structures on the field channels whereas the other two regions were using in-situ constructed structures. Pre-cast structures were found to have been outflanked in filling reaches. Use of these in

such reaches would need additional in-situ embedding work. Detailed comments of the Team are available in Annexure-IV.

(5) Quality Controls:-

(i) The tests as described for dams are being done for earthwork in heavy filling reaches of canals and structures of larger sizes. The Evaluation Team understood that one section officer with each Dy. Engineer, after receiving a special training, was assigned to exclusively look after quality of works. In some heavy filling reaches where individual compaction of banks was not possible, the full embankment has been compacted to required density and canal section has been cut out of it as a cunnet. To ensure correct bed slopes, one permanent bench mark has been established in each kilometer and masonary/concrete profiles have been constructed at frequent intervals.

(ii) The one vital factor in ensuring quality of canal works has been the performance test prescribed at the stages of Bench Marks III and IV. In view of the importance of this test in the exemplary success of the MMIP and its very wide all India implications, the Evaluation Team is devoting a separate section to it. At this stage it would suffice to say that the said test has ensured a very high quality of work on all the sub-projects visited by the Evaluation Team. It has inculcated a culture of self imposed discipline in the quality output of the ID.

(iii) The officers of RMIC also exercise control over quality of works by frequent visits to each sub-project. These cells are functioning in the offices of Regional Chief Engineers and were found to be actively associated not only with construction agencies but with farmers as well.

c. Drainage

Each sub-project has a drainage plan duly prepared for effective drainage. The commanded areas are small and highly undulating. Planning of over-all drainage is, therefore, not a complicated matter. In some of the sub-projects visited by the Evaluation Team, the farmers themselves have been shaping their lands. Since soil cover in most areas is limited, these operations have a severe limitation. Land shaping may have to be ultimately done in strips ensuring a minimum soil cover. The drainage requirements of individual fields will undergo considerable change based on the final land levelling. The Evaluation Team is therefore of the view that duly trained ID staff should provide guidance for field shaping works on each farm so that these fit into the over all drainage plan. In the meanwhile, such drainage structures should be provided as are needed for the system as a whole. No drainage works done by the GOM/ID came to the notice of the Evaluation Team.

3. PROCEDURES

a. Bench Marks

USAID and GOM/ID have incorporated a system of Bench Marks for various stages of each sub-project after each of which, a percentage of cost is being reimbursed by USAID. While these benchmarks enable periodic disbursements, they have been ingeniously demarcated so as to serve as very crucial monitoring points to ensure systematic execution of the sub-projects in accordance with the standards laid down. The activities required to be completed at each BM have been detailed in section-A of the report.An analysis of the bench marks would show how effectively these have worked in exercising full control on essential standards.

(1) Bench Mark I

Plans and estimates of sub-projects in full details are prepared by the Executive Engineer concerned and are examined by the Superintending Engineer. These undergo further Scrutiny in the Chief Engineer's office by the RMIC who then pass them on to the SAEC. The sub-project is then approved by the Minor Irrigation Committee and is sent to the USAID. The checking at all levels essentially looks into its conformity with standards as prescribed under PIL No.3. It is only after this that the sub-project is examined again in the USAID office and acceptance given.

(2) Bench Mark II

This stage of performance establishes finalisation of detailed designs as per Annexure A-1 with active farmers' participation. Farmers' participation in this pre-construction phase has been conducive to design of a more effective and acceptable conveyance system and has imparted a sense of involvement in the farmers which in turn has been very helpful in smooth progress of the sub-projects. Completion of this bench mark is again checked by RMIC, SAEC and the USAID(LCU).

(3) Bench Mark III

Achievement of this bench mark is possible only after a dynamic performance test of canal system (to serve 75% command area and 30% of Part I) works is done. This dynamic performance test is by and large a full scale quality test for all works as also a test for field application in the 30% command area where Part I works have been completed. The test is done jointly by construction wing, management wing, RMIC and SAEC with USAID(LCU) looking on, to be able to recommend release of funds.

(4) Bench Mark IV

Completion of this stage has to be verified by operation test at lower discharges up to 50% of designed capacity. This is overseen by all organisations as for B.M.III. In order to ensure compliance of all standards particularly for conveyance system a detailed check list has been evolved which has to be certified by the construction Executive Engineer. A copy of this exhaustive checklist is appended as Annexure B-2 to illustrate the thoroughness with which adherence to Standards is being watched. At this stage a notice board is installed at each outlet indicating names of farmers, revenue number of holding and its area. A chak plan showing the chak, its fields, field channel and turn outs for each field has to be handed over to the Chairman of each Outlet Committee. The construction wing among other details hands over the following to the management wing.

(i) a) Reservoir details
b) Tank capacity curve
c) Water inflow data and pattern
d) Pan Evaporation and seepage measurement record
e) Maximum & Minimum temperature record

(ii) a) Canal system details
b) Operation test results of canal and each field channel of the system
c) Farm and farmers' data under each chak
d) Soil classification of command of each chak.

It is only after this and its complete verification by the LCU/USAID that final disbursement is done.

b. Implementation on Field

On going through the process evolved by the USAID, and ID, the Evaluation Team has no hesitation in recording that

standards prescribed are being faithfully followed and the procedures to monitor the same are being complied with in case of all sub-projects.

4. ACCEPTANCE OF STANDARDS AND PROCEDURES

The Team found that the standards have found wide spread acceptance in the GOM/ID. In fact, instead of any resistance, the staff was found to be having a feeling of a job well done and a satisfaction that for the first time they feel sure of having constructed a system that ensures supply of water to every single cultivator of the Command. The Team would like to place on record the enthusiastic response of the ID to implement the standards and procedures with sincerity of purpose.

5. CONCLUSIONS

The ID of GOM has been known for its professionalism. They have detailed design and construction manuals. The present project also prescribes following, by and large, the same standards with an effort to update some of the empirical formulas on basis of studies and records. A studious adherence to these standards as envisaged in PIL No.3 followed by performance tests have made a tremendous difference in the results. It is quite common that generally irrigation projects, contemplated to provide irrigation facilities to certain areas, are not found to be doing so. The development of irrigation is slow and in most cases the ultimate potential is never achieved. The Team felt that the procedures adopted for these sub-projects and the attention given to technical designs is worth emulating in all sizes of projects not only in Maharashtra but all over the country and is sure that it will make an impact on the irrigation sector, which will be felt for all times to come.

6. RECOMMENDATIONS

The Evaluation Team recommends the following:

(a) The standards and procedures adopted for the MMIP should be widely publicised for adoption in the minor irrigationsector all over the country. The Bench Marks and the performance tests can be of great use in all developing countries. Their adoption by other agencies like the ADB, the WB, the EEC & etc. can bring about spectacular results.

(b) The work on finding out new hydrological relationships for yields and peak floods is very important. It should be continued. Necessary Technical Assistance particularly in computerised analysis for the same should continue to be provided by the USAID till meaningful conclusions are available. The Evaluation Team anticipates that the work may take another about three years.

(c) The GOM should continue the silt studies as per procedure established by them on each sub-project. This study should be extended to other representative reservoirs in the state in a methodical manner. The results on basis of which, the revised standards have been established were also widely varying. The Team feels that more details have to be collected and analysed so that the problem can be reviewed.

(d) The drainage work on each sub-project needs to be attended.

C. PERFORMANCE TESTING PROCEDURE

1. INTRODUCTION

The USAID and GOI entered into the agreement for MMIP for GOM in July 84. It was, however, in Jan.86 that performance based disbursement was incorporated vide PIL No.4. The disbursement were correlated with stages of individual sub-projects and described as Bench Marks as per Attachment-B of the above PIL. A copy of the attachment is enclosed as Annexure C-1

It appears to us that considerable thought had gone into devising these Bench Marks as they represent crucial stages of the project and incorporate in them the fundamental objective of field deliveries of water. The releases for Bench Marks III & IV were to be subject to verification of physical completion. The verification for head works does not pose a problem as with filling of reservoir, seepage pattern observations, behaviour of surplussing arrangements and head regulator give sufficient indication of their general health.

Verification of the conveyance system is however a different matter altogether. Normal procedures being followed in almost all countries, including India, have been to check the canal cross-sections, bed slope and general condition of structures. While such a checking gives an overall idea about conformity of constriction with designs, the actual situation is far more complex. A single constriction in channel section, a small error in openings provided in structures, a slight change in bed slopes can effect the discharging capacity of the system as a whole and throw the field deliveries completely out of gear. It is these small but crucial points which get in the way of achieving full irrigation potential in a very large number of projects.

It was obvious to the Team that more than mere verification of physical completion, the person or persons who applied their minds to evolving the method had intimate knowledge of the actual difficulties faced by farmers and the real reasons thereof. But for a prolonged exposure to field and its detailed analysis in Indian conditions, the idea of prescribing a Performance Test from head regulator down to the farm gate could not possibly have germinated. We can also visualise the initial resistance that such a proposal must have met. This proposal was strongly supported by the Keller Evaluation Team in middle of 1987 and was eventually accepted by GOM.

Performance testing has come to stay in MMIP. It is being extended to the entire MI sector of GOM as per a Supplemental Bench Mark prescribed in Jan 91 under PIL No.52. During our discussions in Bombay and Pune with ID officers, we learned that they intend to extend it to smaller units of their larger projects as well. The concept of Performance Testing of conveyance system, as the Team foresees, will enable assured water supply to each farm gate and has the potential to revolutionise the irrigation efficiencies not only in Maharashtra but in the entire country. <u>The Team was so impressed and enamoured by this test that it would like this procedure to be publicised extensively so that it is adopted in every conveyance system in the country irrespective of the size of the project</u>. Needless to say that larger systems will have to be broken down to smaller units for testing and the test parameters will need to be modified suitably for an overall test. The Team is confident that its introduction all over the country, will rectify many of the maladies with which the irrigation sector is presently suffering.

2. PERFORMANCE TEST

The test covers the following observations and is meant to check its performance at full designed discharge.

(a) Discharge of canal immediately below Head Regulator

(b) Discharge at offtaking point of each minor and in each minor

(c) Travel time of water from head to different points upto tail

(d) Discharge at head of each outlet and discharge at its tail

(e) Travel time of water from head of outlet to the last turn out

(f) Identification of reaches with disturbances and with heavier seepage

(g) Actual loss of head in various structures

(h) Seepage losses

(i) Leakages from structures

(j) Full supply level is marked on all structures and profiles including those on field channels

It also permits conclusions to be drawn on points mentioned below:

(1) Capability of canals to carry designed discharge

(2) Heavy seepage reaches requiring treatment

(3) Travel time of water and time taken for stabilisation of FSL

(4) Improvements/touching up needed in structures and canal

(5) Actual FSL compared to designed FSL and its hydraulic gradient

(6) Actual losses in different parts of the system and total losses

3. OPERATIONS TEST

At completion i.e. at Bench Mark IV Stage, the system is also tested for operational flexibility with varying discharges going down to up to 50% of the full designed discharge. It indicates:

(a) The canal releases required for different rotations of outlets
(b) Actual losses in canals with varied discharges.
(c) Feasible operational sequence of outlets and control structures

The observations to be taken are the same as for performance test.

(a) The test enables following conclusions to be drawn:
    (i) Discharges required for operation of different sets of outlets,
    (ii) Actual canal losses compared to designed losses and their variation with lower discharges
    (iii) Feasible operational sequence of outlets, use of control structures and matching canal operation
    (iv) Travel time for different discharges
    (v) Sizes of obstructions needed in parent channel to draw full discharge in outlets for lowest channel discharge.

4. TRIAL RUN

Prior to having performance/operation tests done jointly with management wing, RMIC & SAEC the construction wing has been conducting its own trial run to identify shortcomings and to rectify them on their own. It is understood that the GOM/ID propose to make it a part of the total performance procedure.

5. DETAILED PROCEDURE FOR THE TESTS

To conduct the elaborate tests described above, considerable preparatory work has to be done. Temporary Cut Throat Flumes(made of plastic) have to be fixed at a number of points, persons have to be detailed at all points duly equipped with proformas and watches to take periodic readings. Patrolling is arranged all along the canal.

The GOM/ID have drafted a detailed Technical Circular giving complete step by step preparations to be made, observations to be recorded including the type and level of supervision needed at different places. The draft relates to conducting this test on minor irrigation projects. Since this draft is complete in itself, a copy of it is enclosed as Annexure C-2 instead of incorporating these details into the body of the report.

It may be mentioned that our split Team which went to Nagpur had made a request to have part performance test conducted on one of the sub-projects. The CEI Nagpur was good enough to have it organised on Wakeshwar MIS. As sowing season was on and longer canal running could upset farmers' schedule, he was requested to have a sample of six outlets run. The details of the test have been incorporated in relevent annexure IV for this sub-project. The Team was very happy to see the canal taking discharge at appropriate levels and the field channels drawing required discharges which were going down to their tails. The intention of having this done was to have a first hand feel of how the test is being performed in the field and its effectiveness. The Team is glad to record that its opinion that the test is very vital was further confirmed both by seeing the water going down to farms as also by the scientific way in which the ID staff was going about it in practice. All
persons deputed at different locations precisely knew what they had to observe and how. It was found that all of them realised the

importance of the test and were keen to do it with all sincerity.

The Team would like to specially thank the CEI Nagpur and his staff right down to sub-professional staff for making it possible for us to witness this part-test.

6. CONCLUSIONS

a. Inspite of having developed large areas under irrigation projects, the IDs of all states in India have always been at the receiving end of public criticism. The Team strongly feels that adoption of these tests for all irrigation systems of the country would take a very major edge out of the public reactions to irrigation facilities. The adoption would ensure desired supply of water to each farmer and he will regain trust in its dependability. With a system that is capable of adequate farm delivery, if timely supplies, as needed, are given by the ID, the production from these projects will achieve its peak in a very short duration. Except for unoccupied lands or lands not under plough and with the support on agriculture made available through AD or Universities, the Team feels that full development should be possible within three to five years. Given a system where water supply is assured and timely, the farmer will continue to improve upon yields from crops adopted at present or by changing over to still better crop patterns. This process of adopting modern agriculture techniques for higher returns from lands has necessarily to go on but its basic starting point is dependable irrigation. The Team is of the opinion that adoption of these tests all over the country will set the ball rolling.

b. The Team would like to mention an apprension also at this stage. There is always a likelihood of some lacunae remaining in conveyance systems. In most cases these come to notice only when the system has been operating. The IDs that adopt these tests will

have to make provisions for rectification of such bonafide shortcomings in the project estimate. If such rectifications start recoiling on the staff, it is likely that the tests may be prescribed but may remain on books only, as many other well-intentioned orders are staying.

7. RECOMMENDATIONS

(a) Farmers' involvement from initial planning stage followed by performance test has infused confidence both in the farmers and the ID about the reliability of the system. This needs to be adopted on all irrigation systems irrespective of their size. It is recommended that the process be given widest possible publicity for adoption in India and other developing countries. Other donor agencies can also be apprised of this unique success story.

(b) The Team recommends that suitable precautions for the performance test not avoidably recoiling on staff should be devised and built into the system. An exchange of thoughts in ID at all levels may be helpful.

(c) The Evaluation Team would hasten to add its belief that the confidence created in and by the ID with the farmer is but a first step in deriving full benefits from the irrigation system. The potential has been created, it must next be exploited and held in place. The farmers' organisations, management information system, and agricultural support services are the other necessary components of the package evolved in the MMIP. Needless to say that while the performance test is the fore-runner, the other steps must follow.

D. INSTITUTIONAL DEVELOPMENT AND LINKAGES

1. INTRODUCTION

The Maharashtra Minor Irrigation Project is intended to increase irrigation efficiency in the state by improving the management and physical infrastructure irrigation systems including distribution, application and utlisation of water below the canal outlet. The project envisages close interaction of all concerned agencies and institutions namely irrigation engineers, agricultural scientists and scientists of allied disciplines and sociologists as well as the beneficiery farmers. Specific roles have been identified for the different agencies at different stages of irrigation planning, operation and monitoring.

Specifically the Project involves close interaction between the following institutions directly related to irrigation planning and development and efficient irrigated agriculture:

(a) Irrigation Department (ID)
(b) Agricultural Departmnent (AD)
(c) Ground Water Survey and Development Agency (GSDA)
(d) Agricultural Universities (AU)
(e) Land Development Banks
(f) Farmers Organisations.

2. IRRIGATION DEPARTMENT (ID)

The Irrigation Department is the lead agency for planning, construction and management of tank based minor irrigation schemes under the project. At the state level ID is headed by the Secretary Irrigation who is assisted by Chief Engineer/Joint

Secretary (Minor Irrigation). The direct responsiblity for project implementation at the field level lies with the Chief Engineers of the six irrigation administration regions of the state. For the effective planning, construction, evaluation and monitoring of the schemes under the Project the following special Committies/Cells/Units have been created:

a. Minor Irrigation Committee (MIC)

The Committee is chaired by the Secretary Irrigation with representatives from agricultural, rural development, finance, planning and other departments at the state level. The Committee provides overall policy and operational guidance for the Project.

b. Special Appraisal And Supervision Cell (SASC)

The Cell is headed by a superindenting engineer and supported by two executive engineers, four assistant engineers, one economist, one statistician, and two deputy engineers. The Cell has the responsibility for preparation of appraisal reports, coordination, planning and design of MI schemes, maintenance of liasion with implementing agencies, USAID and GOI as well as manpower training and development

c. Special Analyses and Evaluation Cell (SAEC)

The Cell is headed by a superintending engineer. It has three executive and coordinates the activities of soil and topographic surveys, water engineers, five deputy engineers, two economists, two agronomists, two statisticians, and one socioligist under the direct control of the Chief Engineer, Pune Irrigation Region who is designated as the Coordinating Chief Engineer for the Project. The following three Units function under the Cell:

(i) Subject Studies and Pilots Unit

(ii) Modeling and Data Unit

(iii) Monitoring, Evaluation and Survey Unit.

Each unit is responsible for studies in its respective area.

d. Regional Minor Irrigation Cells (RMIC)

There is one RMIC in each irrigation administration region under the control of the respective Chief Engineer. The Cell is headed by an executive engineer with two deputy executive engineers, two sub-divisional agricultural officers and four junior engineers. It is responsible for monitoring the project construction and assisting the irrigation circles in the respective regions in the preparation of project reports for MI schems. It also monitors distribution system planning and land development works of MI schemes in the region. Further, it assists in data collection and minor irrigation model application for preparation of scheme reports, ensuring quality control in the schemes as well as monitoring and evaluation of the schemes in the region.

e. Irrigation Circles

The regular irrigation circles under the chief engineer are responsible for planning and construction of MI schemes. They are well staffed according to the GOM norms.

3. **AGRICULTURE DEPARTMENT (AD)**

Services provided by AD include:

i) Dissemination of information on improved agricultural technology amongst farmers of MIS command areas,

ii) Planning/monitoring of input requirements and distribution,

iii) Soil conservation and land development works.

In addition, a number of state sector schemes in horticulture, livestock, cashcrops, etc. are the responsiblity of the AD. These services are operated through the regular organisational network of the AD.

AD is headed by the Director of Agriculture. It has 7 regional divisions covering extension and input planning. Each of the regional divisions covers 3-4 districts and is headed by a joint director of agriculture, assisted by deputy directors and superintendant agricultural officers. Below this level the responsiblities are coordinated at the district, block and village levels. Planning/monitoring of inputs operates through the agriculture development officers, block development officers and agricultural extension officers.

The soil conservation section of agriculture department (AD/SC) is responsible for carrying out Part I and Part II works of MIS at the field level from the point where the ID responsibility ends. The AD/SC has 40 soil conservation divisions and 200 sub divisions under the control of an Additional Director (Soil Conservation) at the state level. The soil conservation program at the regional level is headed by a joint director of agriculture and at the district level by the divisional soil conservation officer. The sub-divisional soil conservation officer functions at the sub-divisional level. The block level program is under the agricultural superviser, each of whom have about 25 agricultural assistants to work at the village level.

The agricultural extension program of AD is under the direct charge of Additional Director of Agriculture (Extension). At the regional level the program is headed by a joint director and at the district level by the subject matter specalist. The sub-divisional agricultural officer functions at the sub-divisional level and block development officer at the block level. The grass root worker at the village level is the village extension worker (VEW).

Each VEW has the responsiblity for 4-5 villages. Most of the areas covered under the MIS are included in the Training and Visit System (T&V) of Agricultural Extension. The T&V provides dissemination of latest information on agricultural technology (crop varieties, input requirements, cultural practices, plant protection requirements, marketing etc.) to the farmers.

The Project had envisaged that about 2 years prior to the scheduled completion of an AID financed MIS, the AD would assign one VEW to each of the systems. The VEW was to be trained under the Project and was to assume the responsibility of helping in the organisation of Outlet Committees and familiarising the farmers in efficient water management. The VEW was to obtain guidance from subject matter specalists (SMS) in water management which the agriculture department had agreed to provide to each district with an AID financed scheme. The AD was to establish two demonstration chaks in each MIS to serve as models for efficient irrigated agriculture.

4..GROUND WATER SURVEY AND DEVELOPMENT AGENCY (GSDA)

The Maharastra Ground Water Survey and Development Agency is organised in the Department of Rural Development and is responsible for the development and utilization of ground water potential in the state. It is well staffed with professionals. GSDA assesses the potential and extent of ground water development in different identified watersheds of the state. The GSDA, responsibility in MMIS is regular monitoring of the ground water resource position at the pre-project stage and at different stages of the post-project period in the region influenced by the MI tank and its water distribution system. The project provides for an appropriate strategy for effective conjunctive use of surface and ground water and the development of guidelines for the utlization of ground water in the area under the MIS command.

5. AGRICULTURAL UNIVERSITIES (AU)

Maharshtra has four agricultural universities, each serving the four distinct agro-climatic regions of the state:

	Name of universitiy	Irrigation region served
i)	Mahatma Phule Agric. Univ., Rahuri	Pune & Nasik
ii)	Punjabrao Krishi Vidyapeeth, Akola	Amravati & Nagpur
iii)	Marathwada Krishi Vidyapeeth, Parbhani	Aurangabad
iv)	Konkan Krishi Vidyapeeth, Dapoli	Konkan

Each university is headed by a Vice Chancellor who exercises overall control of the activities assigned to it under MMIP. The Director of Reserch of the University has the direct charge of the project at the university level and extends the required support for the implementation of the pilot activities agricultural support to the farmers of MIS. The Director of Reserch is supported by two other scientists at the university level. The operational area of the university is the region of their responsibility at the state level. The responsibility of the project in a particular MIS lies with the head of the research station of the university/assoicate dean of the agricultural college in the area. They are assisted by a team of subject matter specialists in the disciplines of agronomy, agricultural engineering, agricultural economics, extension and soil science.

Though it was envisaged that the AD would assume the responsibility to implement the technology transfer program of pilot projects of each AID supported MIS during the implementation stage, this assistance was not forthcomming. However, AD later agreed to assume the responsibility in case 23 MIS, out of the total of 90. Therefore, the major responsibility for establishing

two pilot projects in each MIS, except the 23 mentioned above, was assigned to the different agricultural universities as under:

(1)	M.P.A.U., Rahuri	24
(2)	P.K.V., Akola	18
(3)	M.A.U., Parphani	12
(4)	K.K.V., Dapoli	8
		62

The universities were assigned the responsibility to recruit one VEW for each of the MIS which was assigned to it under the program. They were to work under the guidance of the senior faculty of the university who were assigned responsibility for the project. The university scientists, assigned to work on the project are given suitable honoraria for their work.

The agriculture department and the universities are responsible for developing action plans for efficient farming practices and obtaining the relevant data useful for irrigation farming. It was required that the university staff established effective coordination with the AD staff in the respective areas.

The major activities of AD/AU included the establishment of 2 pilot demonstration chak each MIS. The programme included the use of efficient croping patterns, adoption of improved crop varieties, land development for efficient irrigation farming, appropriate agronomic practices for the crops and land preparation and field layout for efficient irrigation, fertiliser use management, weed control and irrigation planning and management, including economic analysis.

6. FARMERS ORGANIZATION

The central object of MMIP is not construction but institutional developments and improved irrigation management below the outlets. The association of the farmers in planning water distribution system layout and efficient irrigation farming practices are well focussed. Development of farmers organis-ations in MIS system planning and operation are discussed in Section E.

7. USAID IMPLEMENTATION ARRANGEMENTS

USAID/India has a Project Officer responsible for the management and implementation of the MMIP. A Project Committee with representatives of all relevant USAID offices provides assistance in implementing the required USAID actions.

At the field level, a Liaison and Coordination Unit (LCU) has been established at Pune. The Unit is headed by an irrigation engineer (team leader) and has specialists in irrigation agronomy, computer science and irrigation engineering. Short term specialists in sociology and community participation are also available to the LCU. The LCU keeps close liaison with ID in planning and design of MIS, and in the field in monitoring work and to understand the problems encountered in MIS operation. Efforts are made at the LCU to bring in the latest concepts and technology in MIS planning, design and operation. It has made major acheivments in planning, design and testing of water distribution system down to farm turnout, The LCU has also extended its support in developing micro-computer program assisted irrigation design and management programs, organ-isational requirments for water users' association for MIS, training plans and requirments for agricultural support program to farmers.

8. OBSERVATIONS AND FINDINGS

The Evaluation Team, has arrived at the following conclusions on institutional development and linkages in MMIP:

(a) The design standards and construction procedures for the dam, the head works and the water distribution system of MIS conform to the specifications prescribed by the Maharastra Minor Irrigation Manual (1983) and are satisfactory.

(b) The MMIP faced major difficulties in obtaining adequate support of the agriculture department. The provision of one VEW for each of the AID supported MIS about 2 years before the commencement of irrigation could not be implemented. The AD, however, agreed to take up pilot demonstrations in 23 MISs out of the total of 90 schemes under the project. It extends to all the MISs the type of help which is available to farmers in non-USAID assisted projects and in non-project areas under its usual functioning. Essentially this assistance was limited to the T&V system of agricultural extension in AD.

(c) The soil conservation wing of AD was to undertake the responsibility for the implementation of Part I and II works of the project. However, these works have not been done by it. With the difficulty experienced in getting the required AD support, the ID, in cooperation with the LCU, tried to obtain a greater involvement of agricultural universities in extending the required agricultural support to the project, than that was envisaged orginally. All the four agricultural universities of the state were involved in this program. A VEW was required to be recruited by the respective agricultural university for each of the MIS in which it was participating and in most projects which have become operational this has been done. The universities have also developed an

organizational structure for the implementation of the pilot projects in MIS and for extending the required agricultural technology transfer service amongst the farmers of MMIP.

(d) The success of the program of involving agricultural universities in MMIP has been varying. In some of the schemes, especially in the Amravati and Nagpur regions, the farmers were appreciative of the assistance provided by the University. The University had established a few useful demonstrations in farmers' fields on new crops and improved crop varieties. The University team introduced a few improved agricultural implements for land shaping, formation of border ridges and furrows as well as improved seed drills for sowing. Assistance was also extended in plant protection. Introduction of sunflower, a cash crop, for instance, was appreciated by the farmers in many of the projects visited by the Team. In most cases the VEW had the required knowledge for assisting the farmers. He obtained guidance of subject matter specialists of the University whenever required. In some of the schemes there was evidence of cooperation between VEW of the University and the VEW of AD under the T&V system.

(e) In some of the schemes, which the Team visited, however, the support given by the VEW and the university subject matter specialists, was inadequate to achieve the objectives of the Project in the area of integrated agricultural development of MIS command areas. In one of the schemes visited by the Team in the Aurangabad region the VEW had visited the project area only three or four times during the rabi crop season 1990-91. He was stationed over 100 km away from the project site and could not contribute anything substantial to the agricultural production program in the MIS command area. In most of the schemes the VEW provided some assistance to the farmers in identifying crop varieties and adopting improved cultural practices. However, a systemic approach to the problem was lacking. Soil fertility surveys were not carried out in most of the MIS command areas.

This resulted in rather arbitrary recommendations on fertilizers and micro-nutrients. Plant protection service required strengthening.

(f) In most of the MIS visited by the Team there was no coordination between the extension wing of AD and the university team which was working in the project.

(g) Significant programs under Part II works, as envisaged in the Project, were not seen at any of the projects inspected by the Team. Efforts on land shaping for efficient water distribution through surface irrigation methods (except through farmers own intiative) and effective on-farm drainage and erosion control was generally lacking the MIS command areas.

(h) Effective communication between the specialists of AU and the AD was inevidence only at a few places, even though opportunities for combined training of specialists drawn from both the organizations as well as other agencies were provided in the Project.

(i) The Project envisaged the establishment of demonstration of efficent water management and agricultural production programs on a pilot basis in two chaks in each of the MISs. Though there were some good demonstrations of high yielding crop varieties and introduction of new crops like sunflower in small areas of a few farmers the whole chak demonstrations as proposed in the Project, could not be verified at the season of the year when the Team visited.

(j) The linkage of AD, AUs with ID cumprise of the following:

(i) AD has a representative in the Minor Irrigation Committee at the state level. It lays down the general policies of MISs and provides the operational guidance to the Project.

(ii) The Regional Minor Irrigation Cells comprising of two Sub-Divisional Agricultural Officers have established linkages with the staff of AD at the regional level.

(iii) Informal association/consultation of T&V staff of Agriculture Department with ID and AU staff.

The linkage of AU and ID staff are as follows:

(a) Joint effort of ID and AU staff in discussions with farmers on the layout of irrigation distribution system, cropping patterns, selections of crop varieties and irrigation scheduling to suit the scheme of rotational irrigation supply at canal outlets.

(b) ID and AU officials participate in estimating the water requirement of crops and irrigation scheduling using concepts of consumptive use of water by crops and critical crop growth stages and management allowable deficts of soil moisture.

9. CONCLUSIONS

(a) ID has developed a useful organisational structure at the state and regional levels to support an intensive program of improvement in MIS design, construction, evaluation, operation and management. It has provided the required support to MMIP in all these areas.

(b) Amongst the support organisations specially set up by ID under MMIP it is likely that the Regional Minor Irrigation Cells may be retained as a regular organisation of the Department to provide for the required coordination and support to minor irrigation projects in the state. The Cell has an interdisciplinary staff comprising irrigation engineers and agricultural scientists. It is also likely that the Special Evaluation and Analysis Cell may be retained with modified functions to serve as a central organisation for compilation and processing of hydro-

meteorological data and providing an effective coordination and assistance service to an integrated program of MIS development and management.

(c) The agricultural support program to be provided by AD, as envisaged in the MMIP could not materialise, except for some local support by the T&V wing of AD. The late stage transfer of the responsibilities of agricultural support to the universities has also not been very effective, except for some success stories on introduction of new cash crops and some improved agricultural implements.

(d) While ID was logically recognised as the lead agency for the implementation of MMIP, AD with an equally important responsibility was not assigned a major partnership in the project. Funding under MMIP was essentially limited to ID while GOM was required to allot special funds for the agricultural support program. In actual practice, however, no significant effort in alloting special funds to AD or assigning a lead role to it appears to have taken place. Incentives like the data processing facility support which was extended to ID was not made available to AD. A main reason for the lack of interest of AD for a special involvement in MMIP could possibly be attributed to these factors.

(e) The lack of a major involvement of AUs to MMIP could be attributed to the following three main points:

(1) Inadequate financial support and incentives to AUs in MMIP, including travel grants.

(2) Absence of adequate agricultural engineering support to MMIP activities assigned to AUs.

(3) Non-provision of senior staff in AUs specifically to support MMIP.

(f) A major limiting factor observed in MIS command areas has been the lack of attention to land development, especially land

le alling, soil conservation works, on-farm drainage and efficient water application methods. These are essentially agricultural engineering activites. Of the four agricultural universities in Maharashtra three have well developed agricultural engineering faculties with highly qualified and experienced staff in the specialised area of soil and water conservation engineering. The Team could not observe any significant involvement of this faculty in the universities' agricultural support program to MMIP. At present the AUs activities are mainly confined to agronomy. The universities also lack an effective organisational structure and adequate funding to support the program.

10. RECOMMENDATIONS

(a) The Team is of the view that agricultural extension at the state level being the responsibility of GOM/AD, should be taken up by it in MIS, giving special emphasis as provided in the Project since the MISs are intended to serve as models of integrated development of land and water resources for efficient irrigated agriculture at the state level.

(b) Any difficulty which AD may have in providing the type of support as envisaged in the Project should be discussed at the state level and ways and means developed to ensure the required agricultural support to the Project.

(c) For sustained agricultural support to the Project it is essential that GOM/AD develops a suitable organisational structure and support mechanism for an effective involvement in MIS.

(d) The state agricultural universities have highly qualified specialists in various disciplines of agricultural science and related technology. Benefits of the findings at the University should be availed by the specialists in AD/ID and transfered to the farmers in the project areas.

(e) Land development is to be situation-specific in most parts of Maharashtra. This is because of the generally undulating topography and the predominantly shallow soils. The system of contour bench levelling/land smoothening coupled with conservation farming practices like (1) contour cultivation, (2) growing of broad strips of close growing crops alternating with intertilled crops, (3) provision of masnory check dams at volunerable points, and (4) erosion proof outlet structures at appropriate locations are the requirements of the project areas in land development. These are essentially on-farm engineering activities which could be carried effectively by qualified agricultural engineers.

(f) Since appropriate land development technology for MIS is yet to be established in a major way in the state, it should be demonstrated to the farmers by establishing demonstrations on pilot basis in selected USAID supported MISs. The Team recom-mends the establishment of two such pilot demonstrations covering the entire command area of selected chaks having different topo-graphical situations in at least one MIS in each district of the state.

(g) On-farm training of farmers in the use of land levelling equipment and land shaping procedures should be conducted in all MISs.

(h) Availability of implements and farm power for land development are limited in the project areas. Land levelling is essentially a one time operation. Hence, small and marginal farmers cannot be expected to purchase their own implements and possess independent sources of power (bullocks/wheel tractor). This service is to be organized through group efforts, preferably through the water users' association or by establishing agro-service centres or by encouraging individual entreprenuers.

(i) On-farm drainage works need to be provided in the MIS command area to ensure effective drainage of rainfall runoff and preventing soil erosion due to accumulation of runoff at vulnerable locations and at points were field drains join the outlet drains. The work would essentially comprise of land shaping effort to provide for unrestricted flow of runoff at non- erosive velocities and will not in most cases necessitate const-ruction of drains. Small drop structures may be provided at selected locations to prevent soil erosion. If AD/SC cannot provide the required expertise in the design and construction of drainage structures this work should be taken up by the Irrig-ation Department through their agricultural engineering staff.

(j) A 'single window system' for the supply of agricultural inputs like quality seeds, plant protection chemicals, fertilizers and agricultural implements, storage and marketing of agricultural products and technical advisory service should be made available to the MIS through the water users asociations/tank committees.

(k) The Team recommends the adoption of the 'Bench Mark' concept in the implementation and monitoring of the agricultural development program in MMIP. This is in line with the similar scheme adopted by ID for irrigation works. The following scheme is suggested for the agricultural program:

(1) Bench Mark I (Agri.)

The activities in Bench Mark I (Agr) is to be taken up soon after the completion of Bench Mark II of ID. It will comprise of the following activities:

(a) Study of the soil survey report and planning of cropping systems and land management practices based on soil irrigablity classification and soil characteristics.

(b) Study of water distribution system layout and understanding of the functioning and limitations of MIS.

(c) Study of topographical maps of outlet command areas and planning of the land development works including land levelling/smoothening, keeping in view the layout of the fields, prevailing land slopes, rainfall characteristics and limitations imposed by soil depths.

(d) Planning of on-farm soil conservation structures (drop structures/small check dams and drainageways) for safe disposal of excess runoff.

(e) Planning of on-farm surface drainage structures (small check dams and outlet structures).

(f) Conduct of soil fertility survey for NPK and micro-nutrients and preparation of soil fertility maps of outlet command areas.

(2) Bench Mark II (Agr.)

The activities of Bench Mark II (Agr.) should closely follow Bench Mark I (Agr.) and should be completed by the time Bench Mark III ID is over.

(a) Organisation and training of farmers in land development and irrigation methods.

(b) Construction of on-farm drainage structures.

(c) Demonstration of use of land levelling equipment and adoption of proper procedures in land levelling/shaping.

(d) Land levelling of the pilot demonstration chaks adopting contour bench levelling filling of local depressions with soil carried from mounds within the field or adjoining areas or other appropriate methods, depending on land slope and soil depth.

(e) Construction of erosion-proof outlet structures and small scale soil saving check dams at suitable points.

(f) Organisation of input service to farmers of MIS (improved seeds and seedlings, fertilizers, micro-nutrients, plant proction equipment and chemicals, farm power and implements).

(3) Bench Mark III (Agri.)

Bench Mark III (Agri) should follow Bench March III of ID.

(a) Establishment of pilot demonstrations in one of the chaks of MI

- Appropriate land preparation
- Right crop variety, keeping in view yields, disease resistance, quality of grain/produce, growth period, soil fertility maintenance, economic returns of the crop.
- Optimum sowing time.
- Improved sowing techniques
- Soil test-based fertilizer recommandations for the crop.
- Plant protection cover
- Introduction of improved implements/machines.
- Storage of agricultural produce
- Marketing service

- Introduction of alternative crop budgets, discussions on sensitivity of return to input levels and market prices
- Discussions on market prices and marketing channels
- Discussions on input availability, especially of seeds of new crop varieties.

(b) Training of farmers of other chaks in the MIS in improved irrigation farming technology

(c) Evaluation of performance of
- land levelling works
- on-farm soil conservation structures
- drainage structures

(d) Development of training aids (visuals/leaflets) on improved water management practices.

(4) Bench Mark IV (Agri.)

Bench Mark IV (Agri) will closely follow Bench Mark IV ID.

(a) Establishment of a second pilot demonstration chak, preferably at the lower reach of the chak.

(b) Motivation of farmers of all chaks of MIS to adopt improved agricultural practices.

(c) Continued evaluation of performance of soil conservation and drainageworks/structures.

(d) Organization of 'Single Window System' of supply of inputs and service to farmers of MIS through farmer associations.

(e) Establishment of well defind storage and marketing service of agricultural produce for farmers of MIS.

(f) Demonstration of

(i) improved irrigation methods

- Contour furrows
- Pulsed furrow irrigation technique
- drip irrigation
- supplemental irrigation through sprinklers
- continued discussions on crop budget, changing market prices and opportunities.

(ii) Introduction of vegetable and fruit trees and related technology.

(g) (i) Techno-economic evaluation of the agricultural production program:

(ii) Continued evaluation of performance of soil conservation and drainage works.

(1) The existing organisational structure in the agricultural universities may not be able to carry out the functions listed in. The organisational structure in the university will have to be strengthened adequately to carry out the functions effectively.

The LCU can extend substantial support in this program and develop detailed guidelines on the different subject areas. The SAEC and RMIC of ID should also extend major assistance in the program. An effective linkage of AU and ID should be established with AD especially in the T&V extension wing and the soil conservation wing

(m) A major constraint in the implementation of a strong agricultural support program is a viable financing arrangement. The Project stipulates that the GOM should make available the required funds to AD for its involvement in MMIP. However, this has not materalised in a significant manner. The Team is of the view that the lack of interest of AD is mainly due to its insufficient involvement in the Project and lack of financial support and incentives given to it in comparision in line with ID. The normal agricultural support to program farmers should be a part of the regular activities of AD and no seperate funding is called for. However, special activities envisaged in the Project require provsions of additional funds for staff and inputs for the establishment of pilot demonstration projects. These funds should form a part of the Project cost.

(n) AD should establish an appropriate organisational structure to ensure an effective agricultural support program. The possibility of having Regional and Divisional (District) Agricultural Support Cells for MIS may be examined. The Joint Director of Agriculture (Soil Conservation) and the Joint Director of Agriculture (T&V) should chair/co-chair the Reginal Cell and the Divisional Soil Conservation Officer and the Subject Matter Specialist (T&V) should chair/co-chair the District Cell. They should have adequate representation from ID and AUs. Additional posts of Block Development officers may have to be provided for the supervision of agricultural program. There is already one VEW provided for each MIS. An effective and well defined linkage should be established with the RMICs and the Regional Agricultural Support Cells.

E. WATER USER'S ASSOCIATIONS AND FARMER PARTCIPATION

1.INTRODUCTION AND BACKGROUND

The establishment of farmers organizations to participate in the operation and management of the MIS was an key element in the USAID/MMIP. Efforts to establish and strengthen farmers organizatons were strategicaly incorporated throughout the project. To a large extent, these efforts appear to have been, and continue to be successful.

Special study No8. "Analysis of the On-Going Studies of How Best To Organize Farmers for Opperation and Maintenance Minor Irrigation System" provided the basis for the structure of the farm level organizations under this project. This study reviewed the long history of farm level organizations dealing with irrigation in Maharashtra and provided a set of "Draft Rules for Outlet Committees" (appendix 1, Special Study No 8) and "Draft Rules for Formation and Functioning of Tank Advisory Committee" (Appendix 11, Special study No. 8).

a. Outlet Committees

The basic unit of farmer organization is the outlet committee (also referred to as the chak committee). It is made up of five elected members from among the farmers served by a single outlet one of whom is elected as the "Outlet Committee Chairman". Its principal duties are to take responsibility for the maintenance and cleaning of the field channels, to collect water applications,to help prepare irrigation schedules, to ensure that irrigation is completed as scheduled,to restrict demand within the water allocated to their field channel, to maintain the flow in the field channel, to liaison and coordinate with the canal inspector,and to

collect an annual per hectare cess to be accumulated and used to pay for necessary repairs to drop structures, field turnouts and so forth.

b. Tank Committee

Each MIS, according to Special Study No.8 was to have a tank committee comprised of the chairpersons of the outlet committees,and various members of the Irrigation and Agriculture Department. Under government order, the tank committee is now made up of five members from a group of eligible irrigators out of which two each will be from the tail and middle outlets and one from the head outlet. The primary duties of the Tank Committee under the USAID/MMI project are to decide the general crop pattern and period of irrigation for each outlet in a rotation, to supervise the schedule of irrigation, to settle disputes, to impose fines and penalities as appropriate and to be responsible for the maintenance of the canal system up to the outlets.

2. OBSERVATIONS AND FINDINGS

a. Farmer Participation During Construction Phase

Benchmark II required among its many provisions that the farmers accept the layout of the field channels, i.e. the distribution system below the outlet, and indicate their concurrence in writing duly signed by the village leader/chairman of the outlet committee. This provision guarenteed that farmers would have an early awareness of the project and perhaps begin to build a sense of ownership and responsibility. Cultivators at all of the projects which the team visited reported having had the opportunity to comment on the layouts. In numerous cases, they reported that changes were made on their suggestions.

b. Confidence of the Outlet Committee Members

Benchmark IV called for the establishment of the outlet committees "to assure that the scheme is effectively utilized" The outlet committees were in place at all of the projects which members of the Evaluation Team visited which had completed BM-IV. Project documents from non-visited projects show the same success with formation of the outlet committees. Members of the Evaluation Team tried with leading questions and suggestions of possible problems to destroy the cultivator's or outlet committee chairperson's confidence in their ability to manage the distribution of water along their field channels. However, given the newness of the projects, none of them have yet experienced their system in complete operation and have not yet had to mobilize the labor that will be required to clean the field channels either for supplemental irrigation during the current Kharif season or for the coming Rabi season. Also, the outlet committees have yet had to deal with water scarcity which is certain to occur given that the systems are designed with a fifty percent reliability. In all cases however,the outlet committee chairmen seemed totally confident. "We know the proportion of the total acreage that each of us irrigates and we will supply labor for cleaning on that basis", said one of them .

c. GOM/ID endorses USAID/MMIP Farmer Organization Concepts

As reviewed in Special Study No.8, there is a history of water user type associations in Maharashtra dating back hundreds of years. Drawing on this experience, and that gained to date on the USAID/MMIP, The GOM/ID on 21st March 1991 issued Government Circular No.CME-1091/(122/90)-IM(R),Forming Tank Management Committee / Outlet Committees on Minor Irrigation Projects in Maharashtra with Annexure 'A', Guiding Principles for Formation of Water Users Associations", Annexure 'B', "Model Structure for Water Users Association", Annexure 'C', "Guiding Principles of Water

Users Association" and Annexure 'D', "Broad Principles to be Incorporated in the Agreement Between the Irrigation Department and the Water Users Association". Under this order some changes have been made to the farmer organizations of the USAID/MMIP. The outlet committees remain with virtually the same responsibilities. The tank committees however will be transitional to the formation of Water Users Association (WUA). The WUA ,to be governed under the general laws which regulate cooperatives, will be the farmer organization which will assume responsibility for the operation and the maintenance of the entire distribution system including all water courses and field channels. Except for this, the tank committee will have the same duties as under the USAID/MMIP These duties will of course be taken up by the WUA on the formation of that body.

3. PROBLEMS ENCOUNTERED AND SOLUTIONS

A report from the LCU of May 1991 gives the result of a formal survey of the farmer water organizations at fourteen of the USAID/MMIP. This research shows that work remains to be done in organization, and in training and raising the level of awareness of the members of the outlet committees. According to this study, on an average, the job is about 50% complete.

Indeed, project documents report that forming the outlet committees has not been without its problems. Arguments over the routing of the field channels are disrupting irrigation in a few places. However for the most part ,the formation of these committees proceed smoothly.

a.Cleaning of Field Channels

The field channels had not yet been cleaned for the coming cropping seasons at the time of the Evaluation Team visits. This

was on projects which have had either one or no full irrigation seasons so that the time for cleaning the channels is approaching for the first time. The amount of cleaning to be done on some of the projects where the field channels are suceptible to siltation from rainfall runoff is quite extensive. It would be useful to determine if it can be accomplished in time to supply the tailenders first as per the planned water distribution system. It is important to identify any problems as they may arise as part of the effort to create and maintain the outlet committees.

b. Positioning of Field Channels

The Evaluation Team noted that by virtue of the topography and positioning of the main canals, there is considerable difference in the length of the field channel per irrigated hectare that the various outlet committee members will have to maintain. For example on one project selected at random the meters of field channel per irrigable hectare varies from 24m/ha. to 78m/ha. across the different field channels Greater difficulties might be expected on those where the length of channel per irrigated hectare is high. This raised the question on one or two projects where the field channels were quite long, if this had been considered in the positioning of the main canal and/or in demarcating chaks. Reshuffling of farms from one chak to another needs to be examined in such cases as shifting of the canal is no longer possible. There is some evidence that farmers have done some of this on their own. In summary, the GOM/ID should consider the relative length of the field channels in MIS design.

c. Formation of Tank Committees

The tank committees are just now being formed in some of the projects in one of the irrigation circles visited by the team. In Amravati Irrigation District, tank committees have been constituted for eight of the eleven USAID/MMIP in the District. The chairman

of the committee at the Dattapur MIS told the Evaluation Team that they were willing and ready to take over the system. He thought that initially they would require some assistance, however he was confident that they are up to the task. The chairman of the tank committee from the Rajur MIS was present at the same meeting and told a similar story. In contrast, the farmers and outlet committee chairmen at the other projects that the Team visited seemed more reluctant to shoulder the responsibilities of the tank committee, particularly the maintenance of the main and any minor canals.

d. Relative Maintenance Burden

One possible explanation for the difference in attitude may be the relative robustness of the systems. The Dattapur MIS is the most solidly constructed of any of the projects which we visited. The drop structures and field turnouts had been built in place of stonework and concrete and are in excellent condition. There was little evidence of siltation in the main canal from either erosion from rainstorms or from reservoir waters. Maintenance of this system will be a much less demanding job than in the case of the Wakeshwar MS in Nagpur Irrigation Circle. There the drop structures and turn-outs were precast and are showing signs of deterioration after only one partial season of irrigation. Because of the land slope and soils, this system will inherently be more difficult to maintain and hence cultivators are more reluctant to take it over. This does not mean that they are not enthusiastic about the project, for they are. The Sectional Officer for Construction has done an outstanding job of developing relations with and working with the chak committees.

Another possible contributing factor to the relative enthusiasm for the formation of the Tank Committee is the relative length and capacity of the main canal and any minors compared to the area irrigated on the different projects. The higher this

ratio, the greater the burden which must be assumed by the Tank Committee. For example, on the Wakeshwar MIS ,the maintenance burden for the main canal will be approximately .0059mcm kms. per hectare of irrigable command while for the Burikanathe MIS, .0130mcm kms. Thus the tank committee at Burikanathe will be assuming almost twice the maintenance burden per hectare of irrigable command as at Wakeshwar.

This is not to suggest that the tank committees can not ultimately take up the task, only that different systems may have to be operated for longer periods of time before sufficient experience is gained so that the outlet committees feel ready for the tank committee step. In addition, there may be a rational for establishing the state governments contribution to maintenance of the main canal system up to the outlets on a formula basis which takes into account the canal bed slope, number of structures to be maintained and the canal length area irrigated ratio. No doubt the total State allowance for maintenance reflects the circumstances under which the canal has to be maintained. However the policy which has been adopted of crediting the Tank Committee with a flat 25% of this amount to help cover their maintenance costs must necessarily mean that cultivators on different projects will be assuming quite different situations when they take over the operation of the system. The GOM/ID needs to develop a formula for assisting the tank committees with the cost of maintenance of the canals and minors which reflects the relative burden being assumed by the WAUs on the different MIS.

4. CONCLUSIONS AND RECOMMENDATIONS

a. Reasons for Success

In the opinion of the evaluation team, the success of the outlet committees and tank committees to date can be attributed to five factors. First is the involvement of the cultivators during

BM-II in the laying out of the field canals. This involvement created, as it must have been designed to do, an early identification with the project. The irrigation authorities, by involving the farmers, were making a statement that they were concerned that water would be delivered as promised in a manner that was as convenient as possible to the farmers. Second was the training given to the deputy engineers for construction who were responsible for motivating the formation of the outlet committees This training was provided by a private sector firm under the guidance of the LCU. The participants were taught leadership, conflict resolution,organization and listening skills. Third was the positive response of the senior and junior officers in the respective irrigation districts to involving the farmers in the construction and then in the maintenance phase of the projects. It was apparent to the members of the evaluation team that these officers valued the relationships which they have and are forming with the cultivators. The impact of irrigation department personnel getting closer to agriculture and the farmers than they may have been, could effect irrigation and irrigation policy in Maharashtra forever. Fourth was the carrying out of the "performance test" during BM-III and the "operations test" in BM-IV. These tests attracted the attention of the cultivators, and among other things , created confidence in them that the irrigation department intended to create the capacity to deliver water as promised. Fifth was the total level of activity created by the USAID/MMIP in the project areas. The university and subject matter specialists , the sectional officer's organizational activities, the visits of the members of the LCU team, and on some projects, the activities of the Department of Agriculture seem to have created an atmosphere of positive expectations that motivates the farmers organizations.

b. Sustainibility of the Concept

Government of Maharashtra, Irrigation Department Circular No.1091/(122/90)-IM(R), which establishes the legal framework of outlet committees, tank committees and water users associations on minor irrigation works in the state, of which there are thousands, is a strong statement in regard to both the impact and the sustainability of the farm-level organizations experimented with under the USAID/MMIP. It is impoortant that USAID extend the MMIP for another three years so that the successes recorded to date can be confirmed as more experience is accumulated with the MIS projects.

Under the continuation (1) the GOM/ID should provide communications training for sectional officers with the further aim of integrating the capacity to offer such training into the program of WALMI (2) the GOM/ID should be responsible for documenting the effectiveness of the outlet and tank committees under periods of water stress with the intent of determining what assistance the committees may require, especially in the beginning years , in operating the systems. This documentation should be undertaken by the staff of each of the Irrigation Circles and the results summarized at the State level. The LCU or its equivalent should establish the framework and data collection methods and train the responsible ID staff in order to ensure a uniform product and to capture lessons to be learned from the many different situations on minor irrigation systems in Maharashtra, (3)the GOM/ID should document the experiences of the outlet and tank committees in the maintenance and repair of structures for the same reasons and using the same methodology as suggested in (2) above.

c. Environmental Concerns

As mentioned elsewhere in this report, the evaluation team expects that the experiences gained from the USAID/MMIP will be closely studied by Irrigation Departments throughout India. It is well known that minor irrigation works are expected to become increasingly important in expanding food production because among other things of (1) a lack of appropriate sites for large and medium sized projects and (2) the opposition of environmentalists and project effected people to large projects. Many environmentalists argue that minor irrigation projects are environmentally preferred because they typically have relatively less effect on projected effected people and because any negative environmental effects are more local and easier to mitigate. Again as mentioned elsewhere , it is recommended that the GOM/ID create the capacity to manage the MIS as conjunctive use systems as is consistent with an environmental approach to irrigation development.

d. Environmentally Sensitive Field Application Practices

In a related manner, the Evaluation Team is of the opinion that the USAID/MMIP offers an excellent opportunity for experimenting with cultivators capacity to employ methods of irrigation which are more environmentally sensitive and would increase application efficiencies and thereby the benefits from the projects. This is especially true in the case of lift irrigation schemes which are associated with the project MIS and in the use of ground water as a part of the policy of integrated use of surface and ground water.

A project extension would allow for experimenting on several projects with the capacity of outlet committees to incorporate hand surge furrow and small basin irrigation into the water

rotation system along the watercourses. The long field runs on many of the projects (often in excess of 100 meters)and the clay content of the soils suggests the potential for savings both in applied water and in the time required to irrigate using surge irrigation techniques. This could result in reducing soil erosion,in reduced drainage and helping to prevent rising water tables particularly in the area close to the reservoirs. It is in these regions where problems may be occurring on some of the projects even at this early stage of development. The Evaluation Team recommends that USAID extend the MMI project for a period of three years in order establish the capacity of the WUAs to incorporate irrigation practices into their rotations which will increase irrigation efficiency and create more environmentally sustainable MIS. The lessons learned from this effort could have broad application in India as well as around the world.

The suggested environmentally managed MIS study should be developed through the LCU or its equivalent who would be responsible for coordinating a training program for the sectional officers and canal inspectors from the chosen MIS on surge irrigation techniques. The LCU should also be responsible for developing a program to document the results and to extend the results as is warranted. WALMI may be in a position to provide assistance on the technical aspects of the suggested pilot effort.

d. Summary

In summary, the Evaluation Team considers the efforts to establish working farmers organizations to have been a success within the time that the USAID/MMIP effort has been in operation. The impact will likely be felt on minor irrigation systems in Maharashta for decades to come through the orders adopted by the Government of Maharashta, Irrigation Department in May 1991. The

opportunity to contribute more to the successful operation of these organizations is great and should not be lost. The relationship between robust reliable irrigation systems, smoothly functioning farmer organizations and a productive agriculture needs to become firmly entrenched.

5. RECOMMENDATIONS

(1) USAID should extend the MMI project for three years to insure that the full experience of farmer organizations is realized and documented for use in other regions of the country and around the world.This should include the capacity of the organizations to utilize environmentally sensitive irrigation practices in their rotations and water management practices.

(2) The GOM/ID should create a capacity to train the additional manpower needed for the full implementation of the GOM/ID order on water user organization. N.G.O's can be employed for establishing the training capacity within the I.D.

(3) The GOM/ID should conduct pilot studies on using N.G.O's to organize WUA's.

(4) The GOM/ID should conduct pilot studies on the outlet committees capacity to handle water saving irrigation practices such as surge irrigation techniques. These techniques have the potential to increase irrigation efficiency and well as make MIS the system more environmentally sustainable.

(5) The GOM/ID should developing an outreach program to explain the total concept of the USAID/MMIP to other regions and states.

(6) The GOM/ID should evaluating the capacity of the tank and outlet committee to handle the maintenance functions with attention to the possible need for government to contribute as a function of system characteristics such as the length of the main canal relative to acres irrigated and the nature of the terrain.

(7) The GOM/ID should evaluate the experience of the tank and outlet committee in dealing with periods of water stress, especially in the early years of the project.

(8) The GOM/ID should create the capacity to manage the MIS as conjunctive use systems as is consistent with an environmental approach to irrigation.

F. ORGANIZATIONAL AND STAFF CAPABILITIES

1.INTRODUCTION

MMIP provides for an effective and sustainable organisational structure for the efficent management, monitoring and evaluation of MIS. It has an effective program to develop staff capabilities in irrigation, agriculture and related areas to ensure an efficent irrigation water management program for a high level of agricultural productivity on a sustainable basis. Details of institutional development and linkages are discussed in Section D.

2. ORGANIZATIONAL CHANGES

a. Irrigation Department

Irrigation Department (ID) has developed an excellent organisational structure for planning, monitoring and evaluation of MIS at the state and regional levels. The following are the special committees/cells established by ID for MMIP.

(1) State Level
   (i) Minor Irrigation Committee
   (ii) Special Appraisal and Supervision Cell

(2) Coordinating Chief Engineer's Level
   (i) Special Analysis and Evaluation Cell

(3) Regional Chief Engineers Level
   (i) Regional Minor Irrigation Cell

Responsibilities and functioning of the above committees/cells have already been discussed. The following organisations have been

very effective in the implementation of MMIP, especially the institutional and management levels:

(i) Regional Minor Irrigation Cells.

(ii) Special Analysis and Evaluation Cell.

Though the above two cells were established as a part of MMIP activity, their roles in minor irrigation development in Maharashtra have been appreciated by ID for adoption in other minor irrigation systems in the state. During the discussions with Secretary Irrigation at Bombay the Evaluation Team was informed that it is likely that the Regional Minor Irrigation Cells will be retained on a regular basis in the state for the effective implementation of the minor irrigation projects. There is one RMIC for each of the six irrigation administration regions of the state. Each RMIC is headed by an executive engineer with two deputy executive engineers, two sub-divisional agricultural officers and four junior engineers. The Cell is entrusted with the responsibility of monitoring the progress of the project at different stages. It assists the irrigation circles in the region in the preparation of project reports and coordinates the activities of agricultural support program in MIS. The Cell also assists in data collection and model application in the operation and management of MIS as well as monitoring and evaluation of the schemes. Continuation of the Cell at the regional level as a part of the state program will be a laudable action towards acheiving better results from minor irrigation projects in the state.

The Special Analysis and Evaluation Cell, attached to the coordinating Chief Engineer, Pune Region, is responsible for (1) special studies and (2) pilot schemes planning and design and diagnostic analyses of schemes proposed for rehabilitation. The Modelling and Data Unit of the Cell is responsible for (1) the develolpment of Minor Irrigation System Model and (2) data collection and model application. The Monitoring, Evaluation and Survey Unit of the Cell is responsible for (1) bench mark and

follow-up surveys through the agricultural universities, (2) compilation and scrutiny of reports on special studies, pilot activities and scheme reports. It also keeps liasion with LCU, agricultural universities and other agencies connected with the MMIP. GOM is examining the feasibility of continuing the Cell on a regular basis in ID or delegating some of its functions to RMICs.

The Directorate of Irrigation Research and Development (DIRD) of ID, has been providing valuable assistance to MMIP in developing and evaluating concepts and criteria for the operation of minor irrigation systems, especially in the area of canal scheduling. DIRD also takes up special studies on evaluation of irrigation structures, and drainage and land developmentaspects of irrigation projects. Their continued involvement in MMIP/MIS will be valuable in strengthening the programs and attaining sustainability.

b. Agriculture Department (AD)

Though AD was assigned the major responsibility of agricultural support to MMIP, very little has been done by AD in support of the Project. It extends the usual agricultural support to MIS farmers. No organisational structure has been established in AD to extend the special support required for MMIP.

c. Agricultural Universities (AU)

Since AD was unable to provide the special support for MMIP the four agricultural universities in Maharashtra were assigned the responsibility to provide the required support to the project. The program mainly comprised of on-farm development, water management and agricultural production programs of MMIP. The universities formed ad-hoc groups headed by the Director of Research of the university and supported by two scientists of the university with assistance drawn from a team of subject matter

specialists in the disciplines of agronomy, agricultural engineering, soil science, agricultural economics and agricultural extension. This group is required to provide the support needed by MMIP in agriculture. The members of the group are also required to guide the VEWs in their functioning .

The ad-hoc groups of AUs, are to support MMIP during its implementation period. Since agricultural extension at the state level is the responsibility of AD, the AU's involvement is only as a short term measure. However, the specialised trainning which AU staff will be receiving in areas like computer application to water management programs will enhance the capability of university staff engaged in teaching and research work. It will improve the quality oi teaching and help in orienting the university's research programs in irrigation and water management to problem-solving areas.

3. FARMERS ORGANISATION

MMIP witnessed a major effort of ID in involving the beneficiery farmers in MIS management. Outlet committees have been formed in all the canal outlets of MI schemes which have become operational. The activities are still in initial stage and substantial improvements could be brought forth in the near future. However, a good beginning has been made and farmers are fairly well involved right from the stage of finalising the layout of field channels to scheduling of irrigation supplies to match soil-plant-water-atmospheric relationships. With the recent decision of ID on farmers organisation, it can be reasonably assumed that outlet committees and a well defined program of farmer involvement in MIS management have come to stay in Maharashtra and its influence could spread to other states as well. ID is also

keen to organise tank management committees and eventually water users' associations. These steps, when implemented, will be trend setters in Maharashtra and at the national level to achieve a much higher level of performance efficiency and economy in irrigation systems.

4. DATA GENERATION FOR IMPROVED DESIGN OF IRRIGATION PROJECTS AND SCIENTIFIC WATER MANAGEMENT

An extensive hydrological data base has been established by the GOM with the major support of MMIP for improved design of all types of irrigation projects and to generate information on soil-water-plant - climate relationships. A total of 275 additional hydrological stations are being established which are spread over the entire state and covering the major river basins. The stations are of two grades depending on the number and sophisticaton of the equipment provided. The Grade A station has instrumentation for measurement of rainfall, evaporation, temperature, humidity,wind velicity and direction, sunshine hours, water quality and silt load. Many of the instruments are of the continuous recording type. Grade B stations have the conventional meteorological instruments to measure rainfall, evaporation, temperature and humidity. Of the 275 stations, 52 are financed under MMIP, 30 Grade A and 22 Grade B stations. Most of the MMIP assisted stations have already been established and the remaining will be commissioned within a few months. The data generated at these stations will be valuable in the application of latest analytical procedures in predicting the water requirement of crops. They will also enable the use of probabilistic computer models to predict the characteristics of monsoon rainfall. This will enable crop planning to best use available rainfall and introduction of protective irrigation practices in kharif crop production with a possible quantum jump in crop yields.

5. DEVELOPMENT OF STAFF CAPABLITY

The Project has included programs to improve the capablity of ID staff in minor irigation system design, construction, operation and management. They include special studies to improve the design criteria of MIS, evaluation of feasibility of rehabilitation programs in MIS, canal water regulation, farmer participation in MIS management, land development and socio-economic survey.

a. Special Studies:

The following special studies were conducted under MMIP:

- Data collection and processing and developing Minor Irrigation Computer Model.
- Diagnostic analysis of minor irrigation systems for rehabilitation
- Establishing criteria for setting of sill levels of minor irrigation tank spillways.
- Evaluation of sizing criteria for minor irrigation reservoirs.
- Analysis of rotational water supply systems.
- Analysis of farmers' participation in MIS.
- Analysis of comparison of cost of land levelling and shaping with underground pipeline water distribution systems and sprinkler irrigation.
- Baseline socio-economic surveys of farmers of MIS command areas.
- Women's participation in irrigated agriculture and rural development in a selected MIS.

All the above studies were conducted by leading institutions in the respective areas. Most of the studies have been completed and the reports are available to ID and other organisations. They provide valuable documents in improving the criteria for MIS design, operation and management and improving staff capability in the respective areas.

(b) Pilot Activities

Pilot studies have been undertaken for in-depth analysis and evaluation of design and operational alternatives in minor irrigation systems and water utilization practices. The following pilot studies were undertaken by different agencies under the auspices of MMIP:

- Selection of cropping pattern and adaptive demonstrations to improve irrigation water utilization
- Conjunctive use & financing of canal and ground water
- Buried pipeline water distribution systems with sprinkler/drip irrigation and demand scheduling.
- Treatment of minor irrigation tank catchment
- Training of farm women in improved agricultural practices and improvement household appliances and activities

c. In-service Training Program for ID Officials:

With a view to improve ID staff capability in MIS the training courses as shown on the following page were organised by ID and through other agencies as a part of MMIP:

In addition, special training programs were conducted for subject matter specialists, canal inspectors and chowkidars of MMIP. A training workshop in MMIP quality control was also conducted. Computer trainings were organised which benefitted 433 officials of ID.

The training courses were organised by ID and WALMI. The LCU provided major assistance in the organisation of computer training courses. The training courses have been beneficial to the staff of ID in improving their capability in MIS. The computer training courses need special mention. The Team saw with great satisfaction the expertise gained by ID staff in computer applications to irrigation projects, especially with reference to MIS.

Table of Training Courses Organized by ID/Other Agencies for MMIP

	NAME OF COURSE (TOTAL NO. OF PARTICIPANTS)	NUMBER OF COURSES CONDUCTED/DURATION
1.	Water distribution system planning and design (274)	6 training course for the 6 irrigation administration regions, and 3 combined special courses conducted at WALMI, Aurangabad
2.	Construction methods of Part I works (168)	6 courses for the 6 regions and 2 combined special courses
3.	Hydro-meteorological instrument operation and meteorological observations (65)	2 courses of 6 days for the 52 hydromet stations
	(165)	5 courses of 3 days for 90 MMIP hydro-meteorological stations
4.	Operation and management of minor irrigation tanks (123)	9 days training for Dy. Engineers and Jr. Engrs.
5.	Operation and maintenance of minor irrigation systems (96)	5 days training of Dy. Engineers and Jr. Engrs.
6.	Motivation attitudes in MIS management and farmer participation (165)	One week training for Dy. Engineers and Jr. Engineers
7.	Orientation training course on water management (23)	55 day training course ID Engr. staff at WALMI, Aurangabad

6. CONCLUSIONS

a. The organisational improvements, special studies, pilot projects and training programs organised by MMIP have played a major role in the improvement of minor irrigation system design and operation and improving the staff capablity of ID minor irrigation projects. ID has established distinct organisational bodies for assistance in MIS activities. Amongst the establishments created as part of MMIP, the RMICs at regional levels, comprising of qualified and experienced engineers and agricultural scientists, are proposed to the retained on a regular basis to suport the minor irrigation programs in the state. There is also a proposal to retain the activities assigned to the SAEC which would then function at the state level.

b. The involvement of AD in MMIP has not been effective in as far as the Project objectives are concerned. The matter needs to be examined at the highest level in the state and a viable mechanism established to provide the required support to MIS.

c. The involvement of AUs has been good, though it cannot attract sustainability in agricultural extension efforts. Maharashtra has a unique position in India in having agricultural universities in all the major agro-climatic regions of the state. Their continued involvement will be necessary to support adaptive research and training programs for MIS.

d. Development of a viable mechanism to involve farmers in MIS management has been an important achievment of MMIP.

e. The hydromet data generated at the stations are valuable in estimating the irrigation requirment of crops and in applying analytical approaches to predict rainfall characteristcs and the influence of weather elements in crop growth and production. The special studies and pilot projects have provided data and

information to improve the design and operational criteria of MIS and application of alternative procedures to solve situation specific problems. The training programs have helped in improving the staff capability of ID in MIS management.

7. RECOMMENDATIONS

a. Some of the special cells and committees of ID which have established their valuable role in monitoring, evaluation and improvement of minor irrigation systems could be continued on a regular basis. The most important amongst them are the Minor Irrigation Committee, Special Analysis and Evaluation Cell and the Regional Minor Irrigation Cells. Their composition and functional responsibilities and the number of specialists in the different subject areas may be reviewed with a view to strengthen the organisations further by giving more weightage to agricultural engineering and agricultural science subject areas.

b. Greater weightage to the disciplines of agricultural science is required in the special cells. The present practice is to include one or two agronomists in the cells. This is a rather narrow approach. Agricultural engineering, agronomy and soil science are to be given almost equal representation at senior level in SAEC and RMICs.

c. The organisation of the agricultural support program of the university needs strengthening by giving a greater responsibility and involvement to the faculties of agricultural engineering and soil science in addition to agronomy.

d. The functional responsibilities of AD and AUs should be well defined and their performance requirements quantified and evaluated on a fixed time frame, as in the case of ID.

e. AD and AUs should be given the required funding and incentives in line with ID for the establishment of MIS models as envisaged in the Project.

f. In-service training facilities should be problem oriented and extended to the staff of ID, AD and AUs to increase their capability in the tasks assigned to them under MMIP. ID

g. Farmers' training should be organised in land development for surface water application methods in each MIS, preferably at or close to the MIS site, a few months before Bench Mark III stage. Training programs in crop management, irrigation scheduling and on-farm water management should be organised prior to main crop seasons for two years after the completion of Bench Mark III and IV stages. The training programs should include visits to demonstration projects/chaks estabilished under MMIP to acquaint the MIS farmers with irrigation system functioning and train them in land development and irrigation farming practices.

9. The Project envisaged the establishment of demonstration of efficent water management and agricultural production programs on a pilot basis in two chaks in each of the MISs. Though there were some good demonstrations of high yielding crop varieties and introduction of new crops like sunflower in small areas of a few farmers the whole chak demonstrations as proposed in the Project has not yet been established.

10. The linkage of AD with ID comprise of the following:

a) AD has a representative in the Minor Irrigation Committee at the state level. It lays down the general policies and provides the operational guidance to the project.

b) Informal association/consultation of T&V staff of Agriculture Department with ID and AU staff.

The linkage of AU and ID staff are as follows:

a) Joint effort of ID and AU staff in discussions with farmers on the layout of irrigation distribution system, cropping patterns, crop varieties and irrigation scheduling to suit the scheme of rotational irrigation supply to canal outlets.

b) ID and AU officials participate in estimating the water requirement of crops and irrigation scheduling using concepts of consumptive use of water by crops, maximum allowable deficit of soil moisture and critical stages of crop growth.

c) Joint training programs for ID/AU staff proposed in the program has not taken place.

G. COMPUTERIZED IRRIGATION MANAGEMENT INFORMATION SYSTEM (IMIS)

1. INTRODUCTION

A computerized management information system was developed primarily for providing the capability to plan and manage the season to season and day to day operation of minor irrigation systems. This particular capability is referred to here as the "irrigation management information system" (IMIS). Creating this capacity established the basis for computerization of a large number of tasks carried out by the GOM/ID. Some of these tasks are closely associated with the IMIS , while others are more related to the internal operations of the ID.

The development of a computerized management information system involved four simultaneously executed activities: (a.) the formation of the Central Computer Development Committee (CCDC), (b.)the procurement of hard ware and software, (c.) training of personnel and (d.) the development of specialized software applications of which the most operationally significant is the "irrigation management information system"

2. OBSERVATIONS AND FINDINGS

a. The Central Computer Development Committee

The CCDC, comprising of GOM/ID personnel from several ID sections, is responsible for giving direction to, setting priorities for and coordinating the computerization effort required for the development and implementation of a management information system. This Committee has met periodically and actively sought input from the LCU.

b. Hardware and Software

The procurement of software and hardware appears to have proceeded in a reasonable fashion. The LCU unit, through the use of long term technical assistance and local contractors provided important assistance in setting up the hardware and developing operational procedures as well in selecting appropriate software packages. Eighteen microcomputers were set up under the project. Project documents show that all of these stations were visited by personnel operating out of the LCU in 1989 and again in 1990. The comments of these experts seem to have been thoughtful and operationally relevant. Continued site visits by micro-computer specialists to assist in hardware problems, expanding certain of the stations into regional computer centers, in initiating the introduction of new software and in advising on networking would be productive

(1) Computer Facilities: Members of the Evaluation Team visited the micro-computer stations at Pune and at Nagpur. At each of these stations careful attention has been given to provide a cool dust-free environment. Standard operating procedures are in place and the facilities were being maintained and used with a great deal of pride.

(2) Available Software: A growing array of software is available and useable at these stations (see Annexure G-1) for a partial listing) The primary software packages are Lotus 123, and DBase. A few programs have been written in QuickBasic Applications, (in addition to those discussed below that are associated with the irrigation information management system ,IMIS) for analyzing hydro-meteorological data, for project design, for computer assisted MIS design and for in-house accounting, personnel and reporting procedures. The wide subject matter applications that have been adopted so far suggest the integration of micro-computers into the GOM/ID is not dependent on the success of any one particular application.

At the present, the software that is available at the different micro-computer stations is not the same because, among other possible reasons, some of it has been locally produced. The GOM/ID should develop procedures for the sharing of applications packages within the ID including WALMI which is the source of some packages.

c. Training

The first phase of the training program covers: (1) fundamental microcomputer operations, (2) irrigation data and project management, (3) management information systems concepts and development, and (4) micro-computer programming in quick basic. The second phase consists of: (1) computer assisted design and mapping, (2) image processing and geographic information systems, and (3) the minor irrigation system model(MI Model) demonstrations. The third phase deals with: (1) minor irrigation system operations and use, (2) hydrological prediction model operation and usage, and (3) using the water scheduling model. The total enrollment in all of these programs to date has been approximately 820. Additional training has been scheduled and will continue through the scheduled end of the project in September.

(1) Results of Training: The training program must be given credit for the development of the expertise which appears to be in the process of creating a solid micro-computer applications capacity within the ID. The output of a training program is to be measured not only in terms of numbers of individuals trained , but the application of that training on the job. This Evaluation Team was impressed with the extent to which the training under the USAID/MMIP has resulted in applications in data management and in the creation of additional applications packages. There is an obvious acceptance on the part of senior administrators on the benefits from computer applications and they seem very supportive

of the personnel under their supervision who have undergone the training and are now contributing to the day-to-day operation of the Maharashtra Irrigation Division and of the management information system.

(2) Training Needs: Given the recent decision of the GOM/ID to extend the structure of farmer organizations for dealing with irrigation that was used in the USAID/MMIP to all minor irrigation projects in the state, there will be a need for more personnel trained in micro-computer applications. There is also a need to complete the full training program for participants already associated with the micro-computerization effort. The Evaluation Team endorses the recommendation of the Final Report,Sheladida Associates, Inc. of December 1990, USAID, Contract No 386-0000-C-7265-00, p31 thru 33. The GOM/ID should provide for training of more personnel in basic skills, on-site visits, familiarization training for senior personnel, user group workshops, and the use of local consultants to assist in software applications. An overall review of the computer effort will be necessary to provide the details of the additional program efforts.

The Evaluation Team also believes that the computer familiarity and expertise that has been developed,along with the procurement of 386 type machines, justifies the introduction of some of the more advanced software packages available from the U.S. Bureau of Reclamation , U.S.Army Corps of Engineers and elsewhere. Familiarity with packages such as GAMS/MEMOS, which can handle non-linear multivariate dynamic optimization problems of the type that can be associated with the conjunctive use of water resources could be of long term benefit to the ID. The GOM/ID should provide training in the application of advanced software packages. This could be invaluable in planning aand managing conjunctive use and efficient field application methods for environmentally sustainable irrigation. This type training need

not be provided on a large scale but could be given overseas to one or two engineers with field experience and who are already trained at the masters level.

d. Development of the computerized Irrigation Management Information System(IMIS)

A computerized irrigation management information system(IMIS) has been developed to assist managers of minor irrigation systems with day-to-day operations. The IMIS is comprised of two linked software packages (1) the Minor Irrigation Data Base Management System (MIDBMS) and (2) the Minor Irrigation Model(MI Model). The IMIS is the core of the "operations plan" which provides the guidelines for managing all of the irrigation and agricultural activities for the minor irrigation projects under the USAID/MMIP. The most recent edition of this software (IMIS) was distributed in July of this year (1991). This is the latest of several versions which were modified as a result of operational trials at several locations during the 1991 rabi season. The IMIS capability is best understood by considering each of its two components separately.

(1) Capabilities of the IMIS Component MIDBMS: The major function of the Minor Irrigation Data Base Management System (MIDBMS) is to provide users at various levels with the capability to search, extract, sort, and consolidate data from the various modules and produce reports. The software allows for entering,modifying and accessing twelve separate data bases which include minor irrigation site specific data, information on chaks, land ownership, crop information, billing information , irrigation rotation information ,tank operation and meteorological data and irrigation department organization details. The software can be used to produce standard ID reports such as daily lake level, seepage registers, monthly climatological summaries water

application lists, billing registers , farmers water applications and so forth. MIDBMS can be used separately, but is linked for operational and planning purposes to the MI Model to form the total irrigation management information system (IMIS)

(2) Capabilities of the IMIS Component MI-MODEL The capabilities of the MI model includes preparation of a PIP, i.e. the "preseason irrigation plan" (which is sometimes called the "preliminary irrigation program"). To develop this plan the manager selects rotation start dates from a crop calendar that includes ideal irrigation dates for proposed crops. The program tests minimum flow period and canal capacity. If the operational constraints are met, a preseason irrigation plan is generated. Another module sums the areas for each crop from the farmer's applications. If they fit within the PIP, the crops can be sanctioned, if not crop acreage must be reduced or alternative plans formulated. During the irrigation season rotational water schedules and times along the chaks and field channels can be calculated based on the starting date selected. Another module can be used for forecasting tank water availability based on the input of hydro-meteorological information collected throughout the current season. Similarly soil moisture conditions of selected crop/soil planting date combinations can be monitored based on calculations or estimates of daily evapotranspiration, effective precipitation and irrigation. The model then forecasts the next recommended irrigation based on Management Allowed Deficit (MAD), the next critical growth stage and the next scheduled irrigation for as many as five soil/crop/planting date combinations. This information is to be used to provide the irrigation manager with guidance in scheduling the next irrigation.

(3) Data Input Issues for IMIS: These last two capabilities are dependent on the flow of meteorological and hydrological data from the site to the computer operator ,back to

the irrigation manager and then his irrigation schedule must be made available to the outlet committees in time to prepare for the arrival of the water.

One of the concerns of the Evaluation Team is that the flow of hydro-meteorological data from the minor irrigation sites to the computer center will be too slow to utilize that data for revising the preseason irrigation plan(PIP). At the sites visited the Team was informed that the data was carried to a computer center either once a week or once a fortnight. Given irrigation schedules of once every two or three weeks for most crops in the rabi season, this data will be of little use in fine tuning the irrigation scheduling. It is highly improbable that it could be analyzed and the results transmitted to the irrigation manager,tank committees and outlet committees in time to modify the preseason irrigation plan. In Nagpur we were informed that a micro-telephone network is to be set up within the year and that this network will help mitigate the problem. The LCU mentions the possibility of lap-top computers being provided at the MIS sites where the hydro-meteorological data is available on a daily basis and where the model output could immediately be put into action.

Additional capabilities of the MI Model are the review of planned and actual evaporation ,seepage, inflow, lift and releases;the calculation of application,canal and field channel conveyance, and overall efficiencies; and the daily irrigated area from the canal outlets. The use of this capability of course depends on data being available from the field on such variables as volume releases at the head regulator and delivered to outlets, farms, and on the fields.

3. CONCLUSIONS

In the opinion of the evaluation team, an impressive set of software packages have been developed to compliment the day to day activities of the irrigation department and to facilitate the management of the USAID/MMI projects. The IMIS and indeed, the entire operational plan for managing the minor irrigation projects goes well beyond the management system available on non-USAID projects.

The irrigation management information system (IMIS) has the potential to both increase irrigation efficiency and to make irrigation systems more responsive to the needs of cultivators and the crops which they are growing. But this system is as yet incomplete and is in its operational infancy. The most recent upgrade of the MI Model supplied by the prime consultants brings irrigated paddy into the crop options for both continuous and intermittent flow irrigation. However issues of management where paddy and non-paddy are mixed are not fully resolved and thus the package is limited in its applications in those circumstances. But more importantly, the system has not yet been applied widely enough to determine how well it performs over varying circumstances of water availability and irrigation system performance.

Excessive water losses from failing structures along the water courses could make careful scheduling superfluous. Likewise a failure of the farmer organizations to hold the rotations or unauthorized opening of turnouts could limit the incentives to fully utilize the capability of the IMIS.

4. SUMMARY AND RECOMMENDATIONS

a. The computerized management information system is in its operational infancy.The GOM/ID should monitor and field test the IMIS for at least another three years in order to identify and solve problems such as assuring a reliable flow of data from the field so that the outputs of the system are both verifiable and timely enough to be useful and to determine if the farmers associations continue to be willing and able to manage their water supply in ways that justify the use of the IMIS system.

b. The GOM/ID should continue to provide computer site visits by specialists from the LCU to assist in hardware and software application problems and to advise on possible networking within organizations.

c. The GOM/ID should arrange for the introduction of more sophisticated software packages for analyzing some irrigation issues and problems.This will involve specialized overseas training a few participants. Consumptive use modelling is one of the important applications which could contribute to the management of environmentally sustainable MIS.

d. The GOM/ID should provide training for more personnel in basic computer skills and in the special software applications needed for operating the management information system on MIS. Non-governmental organizations should continue to be used in this effort.

e. USAID should provide the continued use of the the outside consultants who have developed the MI Model because the model needs to be extended to be able to handle paddy and non-paddy crops in the same rotation.

The early involvement of the cultivators, the performance and operations tests, the farmer organizations and the support activities to agriculture along with the IMIS are a package of activities which has been created to increase farm income and consequentially the returns from investment in irrigation. How critical are the various components of the IMIS to this package? How much,if any of the IMIS capability is necessary to insure the long term viability of the farmer organizations and the integrity of the minor irrigation systems? It is critical that these questions be answered in support of the GOM/ID decision to extend farmer associations and operations tests to the full compliment of MISs in the State.

f. The Evaluation Team strongly recommends that the GOM/ID establish a system be created review and evaluation of the use and successes and failures of the IMIS for the purpose of determining its total contribution to increasing the efficiency of and net returns from irrigation. The importance of the issue suggests that review should not be conducted solely by the personnel of the LCU or GOM/ID but should possibly include outside consultants.

H. WATER AND LAND MANAGEMENT PRACTICES

1. INTRODUCTION

An important objective of MMIP has been to introduce improved design criteria and efficent land and water management practices to improve the performance of minor irrigation projects. The support activities to achieve this objective included the establishment of hydrological stations, demonstration chaks and the conduct of special studies, pilot activities and diagnostic analyses to support planning, design, operation and management with a view to improve MIS design standards and obtain a high level of sustained agricultural production.

2. HYDROLOGICAL AND METEOROLOGICAL STATIONS

The hydrometeorological and river gauging stations established under MMIP are yielding data which will be of great value in predicting crop water requirements, adopting the latest available analytical techniques. In addition the MMIP provided computers to facilitate the recording and analyses of data from 542 raingauge stations and 82 river gauging stations in five districts of the Krishna and Bhima basins in Maharashtra. ID provided additional hardware to outfit a small computer center within the irrigation projects and the Water Resources Investigation Circle located in Pune. This center has really taken hold. Prior to the establishment of the center, the publication of hydro-meteorological data series was 4 to 5 years behind. It is reasonable to expect that the series could be brought up-to-date by 1992. Reservoir level automatic recording gauges have also been provided at selected sites. The data provided by these stations,

along with the new computer capacity, will provide the capability to modernize the century old runoff prediction procedures, facilitating improvements in irrigation system design process.

3. DEMONSTRATION CHAKS

Two demonstration chaks were to be established in each MIS under the Project. However, in the absence of the special support of AD, the establishment of these demonstrations were delayed. With the AD unable to supply the necessary support activities, the state agricultural universities were brought in to provide the required agricultural support to the Project, including the establishment of demonstration chaks. The university teams conducted demonstrations of improved crop varieties and cultural practices in some of the schemes. The introduction of new crops like sunflower was highly appreciated by the farmers who could obtain substantial gains in farm income. The introduction of simple animal-drawn implements like two-bowl seed drill, ridge former and leveller were also appreciated by the farmers. In some of the schemes demonstration chaks have also been established. However, this program need to be strengthened substantially. Agricultural engineering support was generally lacking in the program even in the universities' effort in the Project. Similarly, the soil conservation wing of AD was not in a position to provide special assistance to the MIS. The universities also were not able to extend the required support in land development in MIS command areas, except for the introduction of an improved land leveller and ridger.

4. SPECIAL STUDIES

USAID/MMIP assisted special studies are intended to provide data and information required for special needs in the planning, design, operation and management of MIS.

a. Data collection and processing and developing minor irrigation computer model. The study involved the following activities: (i) Monitoring of ground water levels during pre-monsoon and post-monsoon periods in the command areas of MIS by the GSDA. The data generated will be useful in evaluating the influence of MIS on ground water recharge and the extent of ground water extraction. It will also help in planning conjunctive use of surface and ground water in MI schemes. Present day recording of ground water levels are limited to two periods, one pre-monsoon observation and another post monsoon observation. These data may not provide adequate information on water table in MIS command areas with reference to crop growth periods. It is desirable to have monthly data of the water table in observation wells in the MIS command area to obtain a better understanding of the water table situation for crop planning and conjunctive use of surface and ground water. (ii) Data collection of hydrometeorological stations of ID. Meteorological data from hydrometeorological stations attached to MI schemes are being received by SAEC, Pune for compilation and analysis.

b. Setting of sill levels of MI tank reservoirs: The results of investigations influenced the revision of design silt load allowance of minor irrigation reservoirs to a much higher value, namely from the earlier provision of 1.6ha-m/100sq.m per year to 6 ha-m/100sq.m per year with even distribution in dead and live storage areas. This also required the revision of dead storage capacity of the reservoir.

c. Analysis of the influence of sizing of reservoir at 50% dependability and command area at 75% dependability: The study confirmed the current practice followed by ID.

d. Analysis of rotational water supply system: The specific recommendations which would arise out of the study which has been undertaken by ID is expected to provide information on canal regulation for efficient water management within the constraints of the irrigation system design.

e. Study of the nature and extent of farmer participation on existing MIS. The study was conducted to analyse the involvement of farmers in the management of some of the traditional irrigation systems in Maharashtra. Khajana well in Beed district, Ex-Malguzari tanks in Bhandara and Chandrapur districts and Phad system in Nasik district were included in the study. The study provided specific information on organising farmer groups in minor irrigation management.

f. A comparative analysis of the cost of land levelling and use of sprinkler/ drip irrigation: Preliminery results of the study indicated that land levelling is expensive as compared to the cost of the work involved and that of providing irrigation through buried pipelines and using sprinklers or drip methods of water application. However, sprinkler and drip methods are highly efficient in light textured soils and the savings in water and the resulting increase in the command area due to the change over to pressure irrigation system could often offset the savings in land levelling costs. Thus, the choice between the two alternatives should be situation specific. The study is incomplete as the design of the buried pipeline system could be finalised only by May 1991 and the field work on the water distribution system can be started only after September 1991, when the monsoons recede.

g. Base line socio-economic surveys: These surveys conducted in selected MI schemes provided a means of assessing the influence of irrigation system on improving the social life and economic level of the beneficiery farmers.

5. DIAGNOSTIC ANALYSES OF EXISTING MIS

Diagnostic analyses were carried out on 12 minor irrigation systems in Maharashtra. The MIS were located in each of the six irrigation administration regions and covered all the climatic zones of the state. All of the 12 schemes were compeleted prior to 1977. The scheme typically consists of a storage tank on a rivulet and a main canal. The annual planned irrigated areas over these varied from 100 ha to 650 ha. The diagnostic analyses uncovered a host of problems. These related to design, construction and maintenance of the system, including: (1) the water supply at the farm gate is unreliable, (2) schemes are both poorly planned and constructed, (3) siltation rates are from 3 to 46 times greater than planned, (4) there are insufficient erosion-proof catchment drains so that excess rainfall runoff eroded the channels leading to the reservoirs and accelerated the rate of siltation, (5) leakage at water distribution system structures range from 50% to 90%, (6) water conveyance losses are 10 to 15% greater than planned, (7) there are no measuring devices to allow management of canal releases, (8) estimates of CCA and ICA are ad-hoc, (9) there is a lack of knowledge on the part of farmers on how the systems operate, and (10) there is no consideration of crop water requirements in planning the regulation of canal supplies. Yet another set of problems related to both irrigation and agriculture. These include: (1) there is no consideration in planning given to conjunctive use of canal supplies and ground water, (2) there is a lack of communication gap between agencies, ie. ID, AD, GSDA and credit institutions, (3) in the absence of water users associations, the village level extension service is ineffective,

and (4) there is a lack of knowledge by ID staff concerning agricultural support organizations available in the area.

The overall conclusion reached by the ID from the diagnostic analyses was that the 12 MISs identified for rehabilitation were in such bad shape that rehabilitation seemed inappropriate at that time, although the costs of rehabilitation were not actually computed. Hence, it was decided that rehabilitation was not justified. It was argued that the institutional problems (lack of farmer organizations and support services) for agriculture would restrict the returns to the physical rehabilitation of the system so much that the investment would not be justified. This was a valuable finding for it emphasized the importance of attending to the institutional as well as the design and construction dimensions of MIS if the USAID/MMI project is to be a success.

The Evaluation Team, however, is of the view that the existing Minor irrigation projects be considered for rehabilitation from the cultivatiators' point of view, rather than using traditional design standards used in the diagnostic analysis. Farmers have the most up-to-date knowledge of how an irrigation system is currently operating and what might be done to improve its efficiency. They have adjusted to the reality of decreased water availability due to reservoir siltation. Most often, if water has economic value, cultivatiors have adopted means of utilizing the so-called "wasted water" through reuse systems. These reuse systems have become institutionalised within the broader irrigation system. Utilizing farmers experience by having the design engineer talk directly with the farmers to obtain their views on rehabilitation has proved to be a valuable and realistic cost effective approach to tank rehabilitation works in Sri Lanka.

The Evaluation Team questions the conclusion that farmer knowledge of irrigated agriculture is not sufficently great in existing MIS to justify rehabilitation of the system. The outlet committee and

the tank committee may be important components and an IMIS model can improve crop production and response. However, this model need not be based on original design standards but could use operational realities as its basis. As for support from AD, the Team is of the view that the cultivatiors of the older schemes are well experienced regarding cropping alternatives and practices and only new crop varieties and cultural practices need to be introduced.

6. CONCLUSIONS

(1) Adequate infrastructural facilities and support activities have been provided in the MMIP to achieve its major objective of introducing improved design criteria and efficent land and water management practices in MMIP. These include the establishment of hydrometeorological and river gauging stations, computer aided data processing facilities, special studies, pilot activities and diagnostic analyses. They have provided valuable information to improve the design criteria of minor irrigation system components and improved staff capability in water and land management practices.

(2) To demonstrate integrated agricultural development for efficient water management and water use efficiency in the command areas of MIS two demonstration chaks were to be established in each MIS. The program has made a good beginning in some of the schemes but requires substantial strengthening and active involvement of the Department of Agriculture. A time- bound program similar to the Bench Mark concept adopted by ID in the irrigation sector will be of great help in achieving the objective.

(3) The special studies sponsored under the Project cover some of the vital areas in irrigation system design, canal scheduling, irrigation application methods, farmer participation

and socio-economic aspects. Some of the studies have been completed recently while others are still in progress. The findings of the study need field testing in representative regions before they could be recommended for large scale adoption.

(4) The criteria adopted in conducting the diagnostic analyses of the 12 existing MISs need to be reviewed. Recourse to farmers' views on the rehabilitation requirements and a better appreciation of the experience of farmers in irrigated agriculture could bring out a different scenerio in which the feasibility of rehabilitation of some of the MISs may become evident.

(5) Data from the hydrometeorological stations established under MMIP are being utlized in refining the procedure for predicting crop water requirments in MIS command areas adopting latest analytical procedures. It has demonstrated its effectiveness in improving the scheduling of irrigation supplies to meet the specific requirements of the crops and the soil. A fairly large number of engineers of ID have received training in computer aided data processing in crop water requirements. The usefulness of the effort will become increasingly evident in the coming years.

(6) Computer aided data processing has been adopted by ID in hydrometerological data compilation and storage as well application of improved data processing in predicting the runoff of MIS catchments. It has alredy brought in improvements in ID efforts in these areas.

(7) The introduction of new crops like sunflower and improved crop varieties and better cultural practices by the agricultural universities in MIS have been appreciated by the farmers of MIS and are being increasingly accepted.

7. RECOMMENDATIONS

(1) Computer aided data processing for estimating crop water requirements and predicting runoff of MIS catchment need wider apoption to cover other minor irrigation projects in the state. Staff training efforts in this area require further stregthening.

(2) The establishment of demonstration chaks in MIS should be given due priority. A comprehensive time-bound action plan is to be developed and implemented for this program.

(3) Special funds will have to be allotted under MMIP for the establishment of demonstration chaks as they form an important component of integrated minor irrigation system development.

(4) The results of the special studies need field testing in representative regions to assess their feasibility for wider adoption.

(5) The procedures adopted in the diagnostic analyses of existing MIS for rehabilitation need review, drawing benefits from the views of the farmers on rehabilitation requirements and taking advantage of their rich experience in irrigated agriculture. This would require a departure from the conventional procedures in dragnostic analysis.

I. PRODUCTION, INCOME AND EMPLOYMENT GAINS

1.INTRODUCTION AND BACKGROUND

Most of the minor irrigation systems completed under USAID/MMIP have been fully operational for less than a year and few of them have had more than a partial irrigated rabi crop. Given this state of affairs the economic and employment potential of the projects and their comparative success must be assessed by considering such questions as the likely time required to achieve the forecast irrigation intensity, farmer's responsiveness in adopting new cropping patterns, and the existence of project benefits which were not considered in calculating the ERR. Some of the evidence used to evaluate these questions is antidotal and was obtained during the field visits of the evaluation team.

It is a difficult task to predict farmer responses to the introduction of irrigation when that response is determined not just by the availability of irrigation water, but by input costs, yields, resource availability and relative crop prices at the time of project completition and thru later years. It is well known that Indian farmers are very responsive in their selection of cropping patterns to relative commodity prices and input costs. There is no reason to suspect that the farmers on these projects will not follow in this tradition.

2.OBSERVATIONS AND FINDINGS

The economic rates of return on the ninety MIS under this project were originally calculated at somewhere between ten and twenty percent. The ERR on the typical project was in the low teens. These projected rates of return are only a few percent lower when recalculated after what has been an almost doubling of costs since the start the project. The reasons for the cost overruns are variously attributed to too low original estimates, rising labor

cost and inflation greater than the seven percent escalator built into the original estimate. However none of these explanations is satisfactory. Data is currently being assembled by the project manager in an attempt to explain quantitatively the reason for the cost overruns.

On the benefit side, increases may be attributed to rising commodity prices and changes in the cropping patterns to include a greater acreage of high value crops. It is not clear how these increases compare to rising input costs except that the increased net returns have been calculated to be sufficiently great to maintain favorable ERRs .

a. Comparisons of USAID and non-USAID MIS

All of the available evidence indicates that the rate of utilization of irrigation and thus production, income and employment potential is considerably better than on non-project schemes. A comparison of two USAID and two non-USAID projects under the Amravati Irrigation Circle which were completed about the same time shows an average 25% greater use of irrigation in the USAID projects. This comparison is for irrigation in the years the projects were completed. Indicative of future potential, in the same years, the two USAID projects were irrigating on average 1.12 (67%)more hectares per Mcft of water releases. This is an impressive difference in system efficiency. It suggests that if the factors responsible for this difference can be maintained, the projects which have had the advantage of the package of activities carried out under the USAID/MMI have considerably greater production potential.

Another comparison in the Amravati Irrigation of eight MIS completed prior to June 1985 shows those projects to be irrigating on average 26% of the rabi season irrigation potential while nine

projects completed under the USAID/MMI utilized on average 52% of the rabi season irrigation potential during the 1990/91 rabi season. This comparative 100% increase in utilization is another indicator of the potential which has been created. It will remain to be seen if it can be held in place.

On a similarly optimistic note, the SASC in Pune reported that some nine of the projects had achieved 100% of the potential irrigation intensity in the first rabi season after the competition of the project.

b. Project Delays in Some Areas

On the other hand, there is little information available as to why only one of the eleven MIS projects in the costal zone of he broader project area has achieved benchmark III and the remainder have completed benchmark II only. The reason given for this is land acquisition problems reported to be generic in paddy areas dominated by smallholdings. Clearly to date no production and income potential has been generated in this area. It would be well to determine more precisely the reasons for project delay as perhaps a valuable lesson related to having identified the projects in the first place, or to identify actions which might have been taken to move these projects forward.

c. Impacts from Hand Dug Wells

A common element on the projects where soil and water levels permit, is the increase in the number of dug wells since the completion of the reservoirs. These wells lie both within and outside of the irrigable command area. They represent an increase in the irrigated area and as such can legitimately be included in an estimate of the benefit streams from the projects. In a similar vein, the six percent of the reservoir water that is

available for pump irrigation is being taken advantage of on many of the sites. At one MIS the evaluation team observed non-commanded acreage in the shadow of the dam that had been fallow, but has been brought under cultivation by investors from outside the immediate farm community. An underground sprinkler system has been installed on an area of about 10 hectares, apparently to grow horticultural crops. This type of experimentation by investors more capable of assuming risk than the average cultivator can be considered a demonstration plot financed by the private sector.

d. Other Unrecorded Project Benefits

Two additional unrecorded direct benefits are (1) the increase in the availability of drinking water in areas that experienced shortages in the hot season prior to the construction of the reservoir and (2) fish production in the reservoirs. Farmers frequently mention the importance of the increase in the public supply of drinking water. The production of fish is under the jurisdiction of the Fisheries Department who auctions off the fishing rights for a given reservoir to fisheries cooperatives. Information is not readily available on the value of the fish produced and marketed by these groups and that value is not included in the calculation of the annual benefit stream from a MIS project.

The GOM/ID should document the additional benefit streams from the MIS including well irrigation, fisheries and public water supplies. All of these of benefits are important and should be documented to become part of the expected benefit streams from MIS. The USAIDid should establish procedures to/MMIP total project provides an excellent opportunity to gather this type of information which be valuable in providing estimates of benefits newly designed projects.

4. PROBLEMS ENCOUNTERED

a. Lack of economic data and analysis

There was little evidence of information on the costs and returns to various cropping patterns and input levels being available to the farmers.This type of information is useful not only to individual farmers but also to irrigation planners. The team was informed that agricultural economists associated with the project as subject matter specialist have prepared some of this information, however none of the agronomists whom we encountered from the Universities nor their VEWs were aware of its existence. The GOM/ID should establish procedures to better integrate economic information and analysis into the advising and planning cycles as the USAID project concept and package of activities is extended to other areas.

b. Lack of Agronomic Information

The lack of agronomic information and the availability of inputs is another factor which is limiting project production and income potential. This limitation is discussed elsewhere in this report.(see section E)

c. Concern for Rising Water Tables and Conjunctive Use

The rising water tables that have created the opportunity for increased project benefits are at the same time raising the concerns associated with high water tables and inadequate drainage.In a surprising number of projects the water table in some areas is above the three meters identified as meriting careful monitoring by the GOM/ID. In some places it is within two meters of the surface. As noted elsewhere in this report, there is a need

for a conjunctive use approach to water management. These USAID/MMI projects appear to this Evaluation Team to present an ideal opportunity to serve as a pilot projects for managing MIS as environmentally sustainable systems. The development of the IMIS provides much of the data base and analytical capability required to take this approach.The GOM/ID has an on-going well monitoring program and is well aware of the importance of the issue.The moment may be right to address a contentious and important issue that has applications well beyond the State of Maharashtra.

d. Employment Growth

The employment growth and potential of these MIS appears to be significant. There was of course a large quantity of labor employed during the construction phase. In addition the growth in total cropped acreage as a result of the projects must necessarily have reduced both unemployment and under-employment. The fuller utilization of irrigation capacity earlier on in the life of these projects compared to non-USAID projects necessarily means that employment growth is relatively greater. The Evaluation Team heard testimony from smallholders who reported that if it were not for their project, they would have had to sell their land and seek employment in the city. The GOM/ID should collect employment information for planning purposes. This activity might be part of a cost accounting system. This data would be helpful in decisions to extend the USAID/MMI project activities to other areas.

4. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The project has not developed sufficiently to be able to gather very precise information on income and employment gains as a result of project activities.There is a good bit of evidence however that these projects are on their way to becoming relatively quite successful.

a. If the USAID/MMI package of activities is be extended by the GOM to other MIS,it is important that the GOM/ID quantify current benefit and cost streams from the USAID/MMIP. This information would be important for project appraisal and expansion of the USAID/MMIP concepts. This should include the net benefits from non-irrigable command acreage being irrigated from wells and other lift irrigation activities,fisheries development, increased public drinking water.as well as the costs of submergence and the loss of income opportunities for effected cultivators. Systemic methods for collecting this information should be developed by the LCU and incorporated into the Minor Irrigation Data Base Management System (MIDBMS)

b. A system of crop cost accounting should be incorporated within the IMIS to provide current information for advising farmers, for planning purposes and for providing a data base for advising investors in lift irrigation capacity in the private sector. This system should especially target new crops introduced into a region.

The activities in both recommendation 1. and 2. should be initiated using consultants working through the LCU while selected engineers are sent for training in economic analysis at the masters level. The analysis being recommended should reflect knowledge of engineering and water management issues as well as of agronomic practices.

c. The Agricultural Universities should develop procedures to ensure that the work agricultural economists is more closely integrated with the that of the agronomists and other agricultural SMS (Subject Matter Specialists).

d. The GOM/ID should carry out a special study to identify detailed reasons why some projects never achieved BM-IJI and to suggest ways of avoiding such delays or undertaking such projects in the future.

e. The GOM/ID should insure the capability to incorporate conjunctive use management should be built into the irrigation management information system (IMIS) in order to help insure the flow of benefits from the MIS. The USAID/MMI Project, because of the capacity already created by the integrated management system, farmers associations system testing procedures, and the ground water monitoring programs of the GOM/ID ,presents a unique opportunity to establish systems for managing minor irrigation systems for environmental sustainability. This has implications well beyond the State of Maharashtra. This is a unique opportunity that should not be lost. The MMI project should be extend for three years on the basis of this reason alone.

J. FOLLOW UP MEASURES TAKEN AFTER LAST EVALUATION

1. INTRODUCTION

The last evaluation was done in July 1987 by a team of four experts headed by Dr. Jack Keller. This report covered the two on-going USAID projects including MMIP

2. FOLLOW UP ACTION

The recommendations made in the evaluation are tabulated below indicating follow-up action taken on items concerning MMIP.

Sl. No.	Recommendation	Follow-up Action
I	Design And Implementation	
(i)	Hydrological Analysis	
	Research effort to improve upon determination of Max. flood and yield be undertaken. Programme of refinement using the rainfall and storage information collected at constructed systems should be established at DIRD.	The work of computorised compilation of data has started for the two major river basins of Krishna and Godavari Rainfall-run-off and PMF-Catchment area relationship are being worked out. Software for PMF, silt deposition and MWL is being developed for dam designs. This is being done at IPWRIC Pune. There is need for more computers to take up this work in other regions and further Technical Support for a minimum of three years to arrive at meaningful conclusions.-
(ii)	Performance Testing	
	(a) To be done right down to farm gate. Checking to be done	It is being done for the entire system right down to farm gate. Test is attended by independent agen-

at sample locations without prior intimation to ID	cies like RMIC, SAEC and LCU and results are jointly signed. The Team also found that both RMIC and SAEC do not always give clearance of the test in routine and convey modifications/ improvements found necessary by letters. After these are complied with, the test is repeated. A sample letter from RMIC on Benikre contained as Annexur J-1. On going through similar record of SAEC & RMIC for some other sub-projects also, the Team considers that the tests are being carried out faithfully and surprise checks as suggested are not necessary.
(b) I.D. establish regular programme of recalibrating structures in each system toring with accurate flow measurements.	The necessity has not arisen on MMIP as most systems have operated only for one or two crop seasons.
(c) Quality control was a major problem and special efforts from highest level are required	The Team was satisfied with the quality of work done on eleven MIS visited by them. This may have been accomplisned as a follow-up of the Evaluation report and as a result of introduction of performance test. Further pursuance of this does not appear necessary. -
(iii) <u>Discharge Outlets</u> Fixed discharge outlets with a slide gate as developed at	This has been implemented.

Nasik be used with modifications - if indicated by experiments.	
(iv) Chak Development	
(a) Farmers' participation to start from Planning Stage & to continue in construction phase followed by field performance feed back & revision.	Farmers' participation is being achieved in three phases at Bench Mark II Stage followed in Bench Marks III & IV Stages. Participation beyond that for performance, feed-back and revisions was also noticed by the Team on all works visited.
(b) Two demonstration farms planned on each M.I.S. be reduced and their quality improved.	So far, two chaks per M.I.S. are being used for demonstration. Since farmers are unlikely to go to see demonstrations on other M.I.S., the present practice may be allowed to continue. The Team feels that it should be posssible for the regional universities to select some of them for being model farms based on agro climatic considerations. It may be mentioned that involvement of different universities was not found to be of the same level in different regions.e Team found an acute need and demand from farmers for continued advice in his field and recommends technical assistance to continue for another three years so that cropping patterns on each sub-project get stabilized on scientific basis and irrigation applications get fine tuned to soil-moisture and computorised

	operation plan.
(c) Bench Mark surveys are useful and may be got done on the pattern of that done for Sina Project by Mahatma Phule University.	This has been done.
V) <u>Conjunctive Use</u> Program be undertaken to improve understanding of ground water hydrology from available additional data from existing wells and logs.	A study for this was done and report given in September 90. It recommended some further studies. The Team was given to understand that a report on on these has been prepared and is under finalisation. We could not lay our hands on this draft report. Looking to rather fast development of conjunctive use and equally fast rise of water tables in some of the sub-projects visited by the Team is of the opinion that this aspect is important and needs to be pursued.
2. <u>Management & Operation</u>	
(i) <u>Operation Plan</u> It should be prepared for normal & crisis include hydraulic operation & effective interaction with farmers	The M.I. System model was tried on some projects in Rabi 90-91. MAD curves & PIP were prepared and irrigation dates were worked out. The software program, meanwhile, had some problems because of which further scheduling & applications could not be tried. Fresh copy of software was available only in January 91. Difficulty is also being experienced as

the computors are located at regional headquarters and there is a communication gap. ID contemplates wireless hook up with sub-divisional headquarters in course of time.
Back-up data of MIDBMS & MIMODEL has been sent to CADI (U.S.A.) for trials, modifications and corrections in soft ware. It was expected back in July 91.

The MIS model has actually not yet been tried on any project even for one season. Its use and exposure of staff of ID is necessary before full benefits from that can be derived. The software itself will need further modifications depending upon feed back on its use. The Team feels that use of such a systems model is being introduced for the first time in India and may leave wrong signals if it gets discontinued before its implications and impact are fully seen and understood. The Team considers it essential to continue technical assistance for this for a further period of three years.

(ii) Modify Operation Plan

a) Operation plan should be modified after performance test, if System characteristics are different from designs.

This was being done but has not yet been practiced due to problems indicated in para (i) above.

b) Flow monitoring

Flow is monitored all through crop

should continue & full performance test be repeated every 3 to 5 years and plan suitably modified.	seasons. The Team feels that an interval of five years should be alright for repeating performance test except if any special problem warrants earlier test on a particular system.
(iii) Caution Even in initial stages before full development. DO NOT allow farmers to over irrigate.	The Team was given to understand that precautions to this effect are being taken. It was found that canals were being run only for 12 day hours. We have elsewhere recommended stoppage of this practice forthwith and have 24 hours scheduling introduced. The Team fully endorses the Keller recommendations and would like to reiterate it with all the force at our command.
3. Water Allocation	
(i) Rotational Water Supply This should be tried with modifications if necessary.	The Team was told that,it is being done.
(ii) Slab System This should continue in RWS as well.	It is a normal practice in Maharashtra for crisis management and is being followed.
4. Water Distribution	
(i) O.A.-(O.C.)Related Special Studies Provide technical assistance to ensure that the two O-A re-	The studies have been completed and outlet committees and Tank level committees are being formed on lines of

lated studies funded under MMIP are completed to high professional standards and disseminated widely.	recommendations of these studies.
(ii) <u>Involve Private & Public Agencies</u> Encourage private and public agencies to experiment with different OA organising approaches. Minimal funding technical assistance & training be provided.	ID is experimenting with involvement of NGOs and will watch the performance. ID itself is already involved in organising outlet committees on its own.
(iii) <u>Studies</u> Sponsor careful quantitative monitoring and evaluation studies of different approaches to enable ID to develop viable set of policies.	Except for the ID generally keeping an eye on comparative functioning, no studies have been started. It is recommended that these studies be started and continued for a period of minimum three years. It is only by that time that comparative evaluation will be possible.
5. <u>Management Information System</u>	
(i) <u>Assess Information Needs</u> ID should undertake a formal & detailed review of its information needs.	(i) to (iii) Work on this field had been started by the ID. Computors were available to them some time towards the end of 1988 and these were put to a number
(ii) <u>Computerisation Fields</u>	of other uses where needs were consi-

ID should computorise the following: a) Administrative operations. b) Planning & Policy formulation c) Design & Development d) Real Time Systems	dered more pressing. Considerably heavy work remains to be done. The ID is also far short of its computor requir- ent both in hard-ware and softwar[illegible] addition they will need expat[illegible]ate technical assistance to develop a really efficient and practical management information system. The Team feels that even their pending requistion for additional equipment is very much underestimated. It is recommended that they may be advised to re-assess this and intermitant expatriate technical assistance should be given to them over the next three years to evolve an efficient Management Information System suited to their requirements.
(iii) <u>Final Development</u> When broad needs are identified, USAID should provide local & expatriate technical assistance to review needs of ID and de-	
6. <u>Main System Hydraulic Modelling</u> (a) Main System Allocation Model be prepared based on theoretical benefits for optimum benefits. (b) Modify it for System limitations. (c) Prepare Main System Hydraulic Model taking full system as existing into account. (d) USAID may provide Technical Assis-	6. (a) to (d) Recommendations given here have already been covered under item 2 above. It is reiterated that continued Technical Assistance in this field for a period of three years is necessary. Leaving this work half way would be nipping in the bud the development of a potentially very good and scientific operation system. In addition all inputs to-date will be completely lost till these are picked up from a scratch
tance to ID to develop	somewhere else under some other exter-

these models, to enable ID to design & operate systems and structures and to train its staff in design & operation.	nally aided project.
7. <u>Economic & Social Soundness</u>	
(i) <u>Economic Analysis</u> Technical, Economic & Management analysis be re-estimated in view of history of only 40% utilization and hydrological over-estimation. Benefits on account of ground water and employment potential should be included.	The recommendation does not pertain to MMIP.
(ii) <u>Low Utilization</u> A thorough study of under-utilization of irrigation potential particularly in kharif season needs to be made. Some of the reasons of this were as under -ID manages to generate low demand -There is unauthorised irrigation which may be by connivance. - Full crop rate is	A special study about under-utilization in kharif had been under-taken. Final action based on this study is understood to be under consideration. One of the reasons for reluctance of farmers to ask for one protective watering is that they have to pay full crop rate. The GOM is shortly issuing per watering rate for kharif. The kharif rates have recently been revised on a lower side.

charged even when only one watering may have been taken. Per watering rate needs to be fixed at least for kharif crops.	There is often a stress period in August which needs irrigation support. It is felt that after promulgation of watering-wise rate, farmers will start taking water and a good part of unauthorised irrigation may also start figuring in records.
Well irrigation, although fed 80 to 90% by stored water, is not accounted for.	As regards ground water, the ID at present has indirect control over it which is not very effective. The Team hopes that the special study on conjuntive use will come out with a solution for the same.
	No study for under-utilization in Rabi season has been undertaken so far. This recommendation perhaps concerns other projects of the state and it would be useful to study this aspect as well.
(iii) <u>Social Soundness</u>	
(a) Recommend independent study to know the plight of resettled people and review policy. To be carried two years after resettlement.	Does not refer to MMIP as there is no resettlement problem. The problem of loss of cultivable land is, however, there. This loss, while not requiring resettlement, does result in a lowered income potential for some cultivators. Access to lift irrigation and employment have been a partial remedy for this problem on some MIS.
(b) Lower level pipes to be put to draw dead water for drinking	Does not refer to MMIP as dead storage is too small.

water supply in hot weather.	
(c) Traditional down stream water supply should be ensured.	(c) Does not refer to MMIP as catchment areas tapped are very small.
8. Professional Development	8.
(i) Needs Assessment ID should undertake training needs assessment study to identify current and future needs.	(i) to (v) These are general recommendations for improvement in the ID as a whole and are not specific to MMIP. Training needs for MMIP were assessed and training program is being followed.
(ii) Induction Training This training is recommended in three phases: I. Emphasising objectives of irrigation II. Higher Technical Irrigation issues. III. Whenever incumbent encounters significant shift in technical responsibilites.	The item does not specifically pertain to MMIP and is meant for ID as a whole.
(iii) Walmi It was recommended that Walmi should emphasise on special training for Main System Manage-	

ment

(iv) Maharashtra Engg. Staff College
It was recommended that Management Science and Economics be included in their curriculum.

(iv) Mahatma Phule Agricultural University
The number and specialization of courses offered in Irrigation water Management be reduced.

9. Future Issues And Needs

(i) Increased Competetive Use
It was recommended that information be collected on pattern of adoption of high value crops and modern irrigation technologies. Incentives needed by small holders to adopt this be studied.

It is a general recommendation for policy decisions by the GOM

(ii) Information and

Analysis Report recommended creation of internal THINK TANK for techni- and analytical work to generate and use new information.	Think tank has been established at DIRD level and has since deliberated on the following issues. (a) Conjunctive use of water. (b) Reservation of drinking water from reservoirs. (c) Rabi equivalent concept for analysing use of water with reference to irrigated crops.
10. Recommended Studies	
(i) Institutional Studies	
(a) Computorisation of hydrological weather data and developing appropriate hydrologic models.	Refer to item 1(i)
(b) Detailed review of information needs at different levels of ID	Refer to item 5
(c) Comprehensive training needs assessment.	Refer to item 8
(ii) Empirical Studies	
a. Conjunctive use of water.	Refer to item 1(v)
b. Rotational water supply	Refer to item 3 (i).
c. Outlet Association special studies.	Refer to item 4(i)
d. Quantitative monito-	Refer to item 4(ii)

ring and evaluation to compare various types of O.A. organisations.	
e. Main system Hydraulic models to be obtained and programmed.	Refer to item 6
f. Reassessment of technical, managerial and economic analysis	Refer to item 7 (i)
g. Under utilization of irrigation potential.	Refer to item 7(ii)
h. Plight of resettled people.	Refer to item 7(iii)

2. RECOMMENDATIONS

(a) USAID may continue to provide technical support and additional computor hard and soft wares for a further period of three years which are needed to come to meaningful conclüsions of the work in hand.

(b) Chak Development

GOM/AU should select a few demonstration chaks from out of existing chaks based on agro-climatic considerations and develop them as model chaks. Farmers from different sub-projects should then be taken to such model chaks for training.

(c) Agricultural Advice

In view of an acute need expressed by farmers and felt by the Team, it is recommended that the USAID may continue Technical support for ensuring that farmers continue to get at least the present level of advice from AU/AD for cropping patterns, modern

agricultural practices and irrigation techniques over the next three years.

(d) Conjunctive Use

(i) The report on this study should be finalised early. GOM should encourage conjunctive use as water tables in most commands have been rising fairly fast.

(ii) GOM/ID may organise farmers' training in WALMI for conjunctive use.

(e) MI Systems Operation Model

The model should be used from coming Rabi season on all sub-projects with full involvement of ID/AU/AD and its quick assimilation in departmental working aimed at. USAID may continue technical assistance to fine tune the model based on feed back for a period of three years.

(f) Caution against over use of water

(i) GOM/ID should ensure that prior to full development, over-irrigation is not done by farmers.

(ii) GOM/ID should stop the practice of running canals for only 12 hours a day and switch over to round the clock irrigation without waiting for full development.

(g) Role of NGOs in organising farmers

(i) GOM/ID should nominate an agency within the department to look after the work of monitoring performance of outlet committees and Tank Level committees got formed through efforts of ID and those formed through NGOs. Such financial assistance as may be needed by GOM to augment role of NGOs be provided by USAID

(ii) GOM/ID may sponsor monitoring and evaluation studies of different approaches to enable ID to develop viable set of policies. USAID may assist GOM for the studies.

(h) Management Information System

(i) USAID may provide computor hard and software as also expatriate technical assistance to enable GOM/ID to develop a really efficient and practical management system.

(ii) GOM/ID may review their pending computor requirements for this as well as hydrological studies and USAID may provide the same by diversion of funds, if necessary.

(iii) The ex-patriate technical assistance will be needed by GOM/ID for a further period of three years which should be provided by the USAID

(i) Low Utilization

(i) GOM/ID may issue per watering irrigation rates for kharif season early.

(ii) GOM/ID may expedite study on low utilization in Rabi season on lines of earlier study for kharif season.

1. Performance Based Disbursements: The use of PBD has proven to be very successful in the MMIP for achieving improved irrigation goals. The accomplishment of improved planning and design; early involvement of farmers; accelerated completion of the distribution system, Part I works, and land acquisition; and performance testing for satisfactory water distribution and delivery to all water users has been attained by the use of this method. Upcoming USAID projects, in which the achievement of performance oriented aims is desired, should contemplate the use a similar strategy of PBD.

2. Completion of Construction: This may be more aptly put as "Lesson Never Learned". The completion of irrigation projects in India almost always takes a longer construction period than originally planned. There are many reasons for these construction delays which may include, interalia; increased costs above those estimated, shortness of appropriated funds, sluggishness of contractors activities, unforeseen acts of God, and more commonly just plain underestimation of actual performance time. The eventuality of these frequent extentions of conatruction timing should be taken into consideration by USAID in the funding of future irrigation projects and allowences made for this purpose. Many of the commonly included project components such as studies, demonstrations and training activities need additional time after project completion to be properly implemented. Additional project time also needs to be allowed for these objectives.

3. Use of Performance Bench Marks: The system of benchmarks, as devised for MMIP, has been shrewdly framed and extreamly effective in achieving the desired performance goals for which it was formulated. It has proven to be popular with GOM/ID and

USAID officers alike. The use of this system should be considered for use in future irrigation projects assisted by USAID and by GOM/ID, as modified for non-donor use, for utilization in their regular program for the implementation of irrigation projects.

4. Multiple Project Components: USAID Project Plans often include a myriad of relevant and well meaning components, many of which apparently have been inserted to please all of the various disciplines of the planning and reviewing teams. MMIP may well be an example of a project that contained just to many varied components for the principle implementing agency (GOM/ID) to successfully oversee, carry-out and administer. This aspet of the project was also noted in the earlier Keller evaluation report. Examples of sound MMIP components which were disapproved, delayed, or did not receive their due attention were: (a) rejecting of the rehabilitation of existing MIS's, (b) exception of the catchment area treatment pilot, (c) slight regard to the drainage, (d) land forming project proposels, poor performance by the AD, and (e) the lateness of obtaining USAID approval for many of the principle project components. The lesson here may well be that for project success its components should be limited to only those that are extremely pertinent to the desired objectives. It may be worth consideration for future USAID projects that the proposals be screened and limited to components that are particularly germane to the goals of the project.

5. Early Farmer Participation: The primary lesson to be learned from this institution building effort is that involving the farmers early in the construction phase and on through to the completion of the MIS has a high payoff in terms of creating a receptive environment for building well functioning farmer organizations.

6. Interaction With Farmer Groups: A second and no less

important lesson is that the personnel of the irrigation department appear to have the innate interest and capacity , given just minimal training, to establish productive working relations with the farm community. This augers well for the development of MIS in Maharashtra.

7. Organisational Infracture: An effective organisational infracture for MMIP implementation in ID is an asset to improving minor irrigation projects performance. The MMIP model of organisational improvement in evaluation and extending assistance in improving MIS components and evaluating the performance of the project has established its usefulness, viability and sustainability.

8. Support for GOM/AD: Assigning the responsibility of agricultural support program to AD without separate provision of funds under the Project and asking the GOM to provide funds for the special activities have not produced the expected results. The AD was unable to perform its role mainly due to lack of funds, incentives and absesence a deep involvement in the project. To achieve the desired objective it is essential that the activities in the irrigation sector and in the agricultural sector are given the due importance and appropriate funding. Seperate funding and well defined performance requirements will have to be assigned to both ID and AD.

9. Integrated Approach to AD and ID: Differential funding arrangement to activities in different sectors of MMIP may lead to unequal development in differnet areas of irrigation system performance. An integrated approach involving ID and AD at senior levels and appropriate funding and incentives to the two agencies to meet the requirement of the project are essential for the successful implementation of MMIP.

10. Individualized Training: Training facilities in specialised

fields should be extended to the staff of the participating institutions in relation to their role in MIS activities. The training courses should be specially oriented to MMIP.

11. Expansion of Computerized IMIS: USAID/MMIP has demonstrated quite clearly that there is a capacity within the GOM/ID to computerize components of their planning, design , and day-to-day operations. This capacity depends on both the willingness to accept the technology and the capacity of the private sector to provide training and repair and maintenance facilities. Computerization of other Government divisions can proceed with confidence.

12. Computerization Indoctrination Period: The introduction of a computerized management information system for managing irrigation systems is a complex process requiring a lengthy period of trial and error and adjustment. The time period allowed in the USAID/MMI project was not long enough to complete the task.

13. Computerization Cadre: The USAID/MMIP has created an opportunity for a body of young engineers to gain skills that will be of important in their careers in the ID. The senior administrators have taken pride in their accomplishments and given them enthusiastic support. This is a meaningful contribution to the total capacity and morale of the ID.

14. Hydro-meteorolocical Data: Systematic effort in

hydrometeorological and hydrological data generation and computer aided data processing are of vital importance in any effort to improve minor irrigation system performance. The models introduced in the MMIP have the scope for wider adaptability in the irrigation sector in Maharashtra and other states as well as for international application.

15. Rehabilitation Information: Inadequate attention given to the views of beneficiery farmers on rehabilitation requirements and insufficient quantification of the prospects and conseqences of rehabilitation may lead to questionable findings on the feasibility of rehabilitation of minor irrigation projects.

ANNEXURES

ANNEXURE I

STATEMENT OF WORK

The purpose of this final evaluation is to assess the progress, effectiveness, results, and probable sustainability of the following critical components of the project with a view of determining the extent to which stated purposes and goals have been achieved; to identify lessons learned; and to make recommendations for (i) GOM/ID regarding further actions to consolidate gains and identify areas for additional technical assistance and (ii) USAID regarding designing new irrigation sector projects elsewhere as well as the areas where further assistance may be needed by GOM/ID. Particular emphasis will be on the following project aspects:

a. Performance based disbursement (PBD) system and its efficacy and adaptability.

b. Performance testing procedures developed to ensure reliability and dependability of irrigation systems created under the project and its adoption and replicability.

c. Standards and procedures used for ensuring progress and quality of construction work.

d. Institutional development changes in GOM's perception, practices and understandings in relation to minor irrigation sector and linkages among irrigation and agriculture departments and agricultural universities forged during the project.

e. Water users associations and farmers participation in determining layout of channels and water courses and assuming responsibility for operation, maintenance and management of irrigation systems created below the public outlet.

f. organizational and staff capabilities created and developed for better project implementation and management.

g. Computerized MIS and its use for demand aggregation, scheduling, billing and accounting.

h. Minor Irrigation System design/operations and efficiency: The extent of water efficiency increase as, a result of improvements in the design, system of distribution, application and utilization of water below the public outlet.

i. Water and land management practices and policy options selected on the basis of data from hydrological stations, demonstration chaks, special studies, pilot activities and

diagnostic analyses.

j. Production, income and employment gains from the water and land management practices and efficient irrigation systems created. (to the extent possible)

k. Follow-up measures taken after evaluations and improvements achieved during the project.

EVALUATION ISSUES

Central issues and key questions related to these project components are listed below to be examined by the evaluation team to come up with definite lessons learned and specific recommendations for USAID.

A. Central Issue: Performance based disbursement

Key Question:
1. What are the lessons learned from the performance based disbursement system that was followed in this project with regard to institutional development and improved irrigation performance?

B. Central Issue: Performance testing procedures

Key Question:
1. What is the extent to which performance testing has ensured reliability and dependability of irrigation systems created under this project?

C. Central Issue: Standards and Performance

Key Questions:
1. How rigorous and effective are quality control and performance standards followed to ensure timely completion and quality of construction work related to irrigation systems?
2. Are these standards and procedures acceptable to officials concerned?

D. Central Issue: Institutional development and linkages

Key Questions:
1. What are the special efforts made and being made to strengthen the institutional linkages among irrigation and agriculture departments

and agricultural universities during the project?
2. How effective and sustainable are the institutional linkages forged among irrigation and agriculture departments and agricultural universities developed during the project?
3. What are the changes in government's policies and practices related to irrigation sector which can be attributed to this project?

E. Central Issue: Water user's associations and farmers participation

Key Questions:
1. What are the efforts made to strengthen water users' associations and transfer responsibilities to them for the management of outlets?
2. How effective and sustainable are the water users' associations created during the project?
3. What is the extent to which farmers participated in determining the layout of channels and water courses and assuming the responsibility for maintaining and managing the irrigation system created?

F. Central Issue: Organizational & staff capabilities

Key Questions:
1. What are the specific changes in organization and staff capabilities that have resulted from the project?
2. How effective and sustainable are the organizational units and staff capabilities developed during the project?

G. Central Issue: Computerized IMIS

Key Questions:
1. What is the extent to which computerized IMIS was developed and used for demand aggregation, scheduling, billing and accounting purposes?
2. What are the factors responsible for its success or failure?

H. Central Issue: Water and land management practices

Key Question:
1. What are the water and land management practices and policy options selected of the basis of empirical

and experimental data from hydrological stations, demonstration chaks, special studies, pilot activities and diagnostic analyses completed during the project?

I. Central Issue: Production, income and employment gains

Key Questions:

1. How substantial are the actual/-potential production, income and employment gains from the irrigation systems created under the project?

2. How do these actual/potential production, income and employment gains resulting from the project compare between relatively more efficient and less efficient irrigation systems?

J. Central Issue: Follow-up measures taken after evaluations

Key Questions:

1. What follow-up measures were taken up to implement the recommendations made by assessments conducted during the project?
2. What were the significant changes or improvements produced as a result of follow-up measures?

EVALUATION METHODS

In order to examine the above mentioned central issues and key questions for final evaluation the following methods are suggested.

A. Use of Available Data

The necessary data are already available in the following documents or reports which will be made available to evaluators at the time of evaluation.

1. Baseline surveys conducted by agricultural universities;
2. Monitoring and progress reports prepared by MES and IC units;
3. Sub-project appraisal reports;
4. Quarterly review reports;

5. Mid-term assessment report by Jack Keller etc.;

6. Field trip/site visit reports by USAID officials;

7. Reports of data collection/processing and minor irrigation system model;

8. Reports on completed special studies, diagnostic analyses and pilot activities (such as setting of sill levels, sizing of reservoirs, analysis of RWS, documentation of farmer participation, how best to organize farmers, part II V/S sprinklers, crop pattern selection demonstration, conjunctive use and ground water development, closed distribution system and demand scheduling, catchment treatment, support to women agriculturists, etc.);

9. Trainer's and contractor's reports; and

10. Relevant statistics compiled by GOM

B. Site Visits and Discussions

In addition to data from available documents and reports, site visits to at least six irrigation projects and discussions with concerned irrigation and other officials at state, region, and sub-project levels are essential. The precise number of irrigation systems at the various staged of completion should be stratified in terms of the four benchmarks and one project from each strata will be selected randomly while ensuring regional representations. In addition to irrigation and agricultural officials concerned, the team should meet the water users from the associations available at each irrigation project site. Relevant data and reports will be collected during the field visits in order to provide answers to some of the key questions related to central issues. In addition to the random selection, projects should be selected purposely on the basis of success or uniqueness to highlight lessons learned.

In order to save time and cover more schemes the evaluation team of four may have to split into two groups and visit 3-4 schemes each.

REPORTS

The prescribed format for the evaluation report to be submitted to the USAID/India includes the following:

1. Executive Summary (covering main findings and recommendations)

2. Table of Contents

3. Body of the report (with one chapter/section devoted to project background and status, evaluation issues and methods, evaluation team and time-schedule, and the rest to major issues and conclusions separately.

4. Annexures

5. References

RELATIONSHIPS AND RESPONSIBILITIES

The evaluation team will consist of four members, of which two will be from the U.S. and two from India. The team will consist of two U.S. Specialists in Irrigation Socio-Economic and Irrigation Sector Evaluation respectively who are familiar with such minor irrigation projects in developing countries, particularly in India or South Asia and two Indian Specialists in Irrigation Management and Irrigation Engineering respectively. The services of the Indian specialists will be processed by USAID through a separate contracting action. The US Evaluation Specialists will act as the team leader to coordinate the evaluation and report writing. USAID and GOM officials will also accompany the team, as and when required, as resource persons with observer status mainly to expedite and facilitate the evaluation work. The contractor will be operationally responsible to the Chief, PDPS/PPE and the Project Officer, NRM, will act as a facilitator to the evaluation team.

ANNEXURE II

NAMES OF OFFICERS MET FOR EVALUATION

I.	AT NEW DELHI U.S.A.I.D.	
1.	Mr. W.G.Bollinger	Director, USAID/India
2.	Mr. J.A.Grayzel	Office Director, NRM
3.	Mr. B.N. Mahesawari	Project Officer, NRM
4.	Dr. B.R. Patil	Evaluation Spec., PDPS
II.	AT BOMBAY	
	GOVT. OF MAHARASHTRA	
1.	Mr. M.Y. OKe	Secretary Irrig. & C.A.D.
2.	Mr. P.B. Umrani	CE & Jt. Sec. Externally Aided Projects.
3.	Mr. D.N. Kulkarni	CE & Jt. Secretary Irrig.
III.	AT PUNE	
A.	GOVT. OF MAHARASHTRA	
1.	Mr. S.E. Bhelke	CE, I.D., Pune
2.	Mr. R.G. Kulkarni	CE, I.D., Bombay
3.	Mr. S.Y. Kulkarni	Director, DIRD
4.	Mr. L.G. Godbole	S.E., SAEC
5.	Mr. K.D. Shinde	S.E., I.D.,Thane
6.	Mr. K.D. Doddihal	S.E., IPWRIG, Pune
7.	Mr. R.V. Chavan	S.E., I.D., Pune
8.	Mr. M.R. Dighe	S.E., I.D., Sangli
9.	Mr. D.K. Panasale	E.E., RMIC, Pune
10.	Mr. G.H. Rotithor	E.E., SAEC, Pune
11.	Mr. Kamble	E.E., M.I.D., Pune
12.	Mr. A.S. Nanaware	E.E., M.I.D., Satara
13.	Mr. A.P. Kadam	E.E., N.R.B.C.D., Phaltan
14.	Mr. G.G. Kanduskar	E.E., O.F.D., Pune
15.	Mr. S.V. Kulkarni	A.E., I.D., Narayangaon
16.	Mr. Pokharkar	Dy.En, M.I., Pune

17.	Mr. B.H. Tonage	S.D.E.,Phaltan
18.	Mr. K.M. Babar	S.D.O., M.I. Phaltan
19.	Mr. D.R. Mali	S.D.O., Veer Dam
20.	Mr. Limaye	S.D.E., RMIC
21.	Mr. G.D. Joglekar	S.D.E., DIRD
22.	Mr. R.D. Kumbhar	Sec. Off., Shirwal
23.	Mr. A.H. Nalwade	Sec. Off. Management Veer
24.	MR. M.J. Pawar	Sec. Off., Malikwadi
25.	Mr. Nalwade	Sec. Off., Shirwal
26.	Mr. R.B. Sawant	Sec. Off., Malikwadi

B. <u>AGRICULTURE UNIVERSITY, RAHURI</u>

1.	Dr. V.S. Mane	Asso Prof. of Agronomy Ag. College, Pune
2.	Mr. P.D. Karwade	S.M.S. Extension
3.	Mr. Jadhav	S.M.S. Agri. Engg.
4.	Mr. Gaekwad	V.E.W., Padegaon

C. USAID

1. Mr. B.N. Maheshwari
2. Dr. B.R. Patil

D. LCU

1.	Mr. P.K. Kulkarni	Team Leader
2.	Dr. B.B. Patil	Agronomist
3.	Mr. S.B. Tagore	Irrig. Engineer
4.	Mr. J. Kedarnath	Computer Specialist
5.	Dr. V.S. Deshpande	H.R.D.

E. FARMERS

1.	Mr. Hanshi Ram Dere	Chairman Chak-2, Parunde
2.	Mr. Raghunath M. Pawar	Chairman Chak-4, Parunde
3.	Mr. Kishan Rao Gaekwad	H.R.D.
4.	Mr. Hanumant B. Pawar alongwith about 30 farmers	

5.	Mr. Appasaheb Anand Rao Deshmukh	Chairman	Chak-4,	Padegaon
6.	Mr. Sanjay Narayanrao Kant	-do-	1	-do-
7.	Mr. Rajendra Eknath Mager	-do-	2	-do-
8.	Mr. Sambhaji Ramchandra Deshmukh	-do-	3	-do-
9.	Mr. Suresh Nivortti Mali along with about 10 farmers	-do-	5	-do-
10.	Malikwadi farmers - 15 nos.			
11.	Sangli (Shirwal) farmers - 20 nos.			

IV. AT NAGPUR

A. GOVT. OF MAHARASHTRA

1.	Mr. M.V. Bhave	CE, ID, Nagpur
2.	Mr. J.H. Navare	CE, ID, Amravati
3.	Mr. A.R. Kulkarni	SE, ID, Nagpur
4.	Mr. N.M. Joshi	SE, ID, Akola
5.	Mr. S.P. Lampuse	SE, ID, Wardha
6.	Mr. P.N. Divekar	SE, PI, Amravati
7.	Mr. D.G. Mathare	EE, RMIC, Nagpur
8.	Mr. V.K. Pol	EE, MIDn, Bhandara
9.	Mr. M.N. Rahate	EE, AIDn, Amravati
10.	Mr. A.T. Ghan	EE, MIDn, -do-
11.	Mr. D.P. Nagrale	EE, MIDn, Nagpur
12.	Mr. Y.B. Suryavanshi	EE, RMIC, Amravati
13.	Mr. N.S. Parihar	EE, MID, Akola
14.	Mr. M.V. Patil	EE, MID, Chikhali
15.	Mr. M.R. Misal	EE, ID, Buldhana
17.	Mr. G.D. Shinde	EE, SAEC, Pune
18.	Mr. W.T, Gurmukhi	EE, ID, Nagpur
19.	Mr. T.S.S. Murthy	SDO, MI(EGS), Nagpur
20.	Mr. S.K. Pankantivar	SDO, ID, Nagpur
21.	Mr. S.M. Sontakke	AE, MI(EGS), Nagpur
22	Mr. P.P. Jirapure	AE,MI, Yavatmal
23.	Mr. M.V. Swamy	SDO, MI, Umrer

24.	Mr. H.S. Wagela	SDE, MI, Nagpur
25.	Mr. R.E. Dhawda	SDO, RMIC, Amravati
26.	Mr. G.B. Komaver	SDE, ID, Kalamb
27	Mr. W.M. Kandalkar	Dr. Eng. MI, Kalamb

COMPUTER TEAM CE'S OFFICE NAGPUR

28.	Mr. M.Y. Rane	AE
29.	Mr. N.G. Oke	AE
30.	Mr. D.K. Rengundwar	AE
31.	Mr. S.P. Paseband	AE
32	Mr. S.V. Dalal	AE
33	Mr. P.M. Puram	SDO
34	Mr. S.G. Mendhi	Sec. Engineer

FIELD NAGPUR & AMRAVATI

35	Mr. D.R. Gajbhiye	Section Off. Wunna Nagpur
36	Mr. V.S. Pauranik	-do- MI, Nagpur
37	Mr. R.A. Tilloo	-do- Management, Nagpur
38.	Mr.A.J. Sorage	-do- Dattapur
39.	Mr. C.B. Pathak	-do- -do-
40.	Mr.E.N. Onkar	-do- Rajur
41.	Mr. P.P. Jirapur	-do- -do-

B. AGRICULTURE UNIVERSITY, AKOLA/DEPARTMENT, NAGPUR

1.	Dr. More	Prof. P.K.V.(Agri.Univ.)
2.	Mr. C.S. Chaudhary	Reader Agronomy -do-
3.	Mr. S.Y. Mohade	SDAO, RMIC, Nagpur
4.	Mr. P.D. Korde	Assoc. Prof. Agri. Engg. PVK, Nagpur
5.	Mr. A.G. Chande	SDAO, RMIC, Nagpur
6.	Mr. G.C. Malvi	Agronomist P.K.V. Nagpur
7.	Mr. Trilok Hazare	ICAR, Nagpur
8.	Mr.P.K. Joshi	DAO, Wardha
9.	Dr. K.K. Thakur	Assoc. Prof. Agronomy PKV Akola/Nagpur

10.	Dr. A.H. Atre	Assoc. Director Agri. PKV, Akola/Nagpur
11	Mr. S.R. Halekar	S.M.S. Agri.
12.	Mr. B.P. Gomase	Assoc. Prof. P.K.V.
13.	Mr. A.K. Mahindra	Dy. S.M.S. Agri. P.K.V.
14.	Mr. D.S. Mahadevan	A.O.(Tev) Kalamb
15.	Mr. S.J. Chowdhary	V.E.W. Kalamb
16.	Mr. Hole	-do- Rajur
17.	Mr. Somatkar	V.L.D. Kalamb

C. LCU

1.	Mr. B.B. Patil	Agronomist

D. FARMERS

1.	Mr. Suresh Maske	Chairman Tank Committee and Chak-2, Telhara
2.	Mr. Ganga Ram Maske	Farmer Chak-3, Telhara
3.	Mr. Bali Ram Nagopure	" " "
4.	Mr. Kevalram Shrirame	Chairman Chak-12,Wadegaon
5.	Mr. Vikram Todase	" " 4 "
6.	Mr. Ratan Shende	Farmer Chak-10, Wadegaon
7.	Mr. Bapu Ziple	" " 11 "
8.	Mr. Manikrao Todase	" " 5 "
9.	Mr. Vithoba Yasan Sure	" Wakeshwar
10.	Mr. Prabhakar Vithal Khonde	" " " "
11.	Mr. Rama Tima Bhoyar	" " "
12.	Mr. Ganesh Vyate	" " "
13.	Mr. Madhukar Laxman Dhobekar	" " "
14.	Mr. Laxman Vithoba Wade	" " "
15.	Mr. Namdev Shamrao Satpute	" " "
16.	Mr. Raju Shrawan Tagde	" " "
17.	Mr. Doinaj Sadashiv Ghaywad	" " "
18.	Mr. Bhaurao Ganba Rewade	" " "
19	Mr. Bakaru Devaji Meshra	" " "
20.	Mr. Padmakar Punjabrao Deshmukh	" " "

ISD

21.	Mr. W.B. Wadatube	"	Dattapur
22.	Mr. P.N. Nagabe	"	"
23.	Mr. P.B. Naik	"	"
24.	Mr. L.K. Thorle	"	"
25.	Mr. S.B. Naik	"	"
26.	Mr. Dilip Rout	"	"
27.	Mr. Prahalad B. Naik	"	"
28.	Mr. D.P. Chamate	"	"
29.	Mr. Devdutta Nowade	"	"
30.	Mr. Divaker Chowdhary	"	"
31.	Mr. Prabhakar Katurkar	"	"
32.	Mr. Janardhan Aoglowe	"	"
33.	Mr. Dinkar Deotube	"	"
34.	Mr. Vasantrao Lodhi	"	"
35.	Mr. Vithoba Watkar	"	"
36.	Mr. Namaji Ekonkar	"	"
37.	Mr. Sharad Aoglowe	Farmer	Dattapur
38.	Mr. Kisan Shelotkar	"	"
39.	Mr. Mandhar Rout	"	"
40.	Mr. Gyaneshwar Rout	"	"
41.	Mr. Yedre	"	"
42.	Mr. Waman Rout	"	"
43.	Mr. Shende	"	"
44.	Mr. Bapurao Aoglowe	"	"

V. AT AURANGABAD

A. WALMI (GOM)

1.	Dr. M.D. Pendse	Director
2.	Dr. S.B. Varde	Jt. Director Training
3.	Mr. M.M. Patwardhan	-do- Research and Extension

B. GOVT. OF MAHARASHTRA

1.	Mr. B.V. Kanchi	CE, ID, Aurangabad
2.	Mr. S.S. Udgirkar	SE, ID, "
3.	Mr. C.Y. Bagal	SE, ID, Osmanabad

4.	Mr. N.N. Joshi	SE, ID, Akola
5.	Mr. N.M. Sonkamble	EE, WR, Aurangabad
6.	Mr. R.A. Dandge	EE, ID, "
7.	Mr. H.B. Dahat	EE, MID, "
8.	Mr. S.L. Chakurkar	EE, ID, Beed
9.	Mr. V.B. Ranade	EE, SAEC, Pune
10.	Mr. J.S. Beldar	EE, RMIC, Aurangabad
11.	Mr. S.A. Pathan	EE, MID, Jalna
12.	Mr. M.P. Bhadke	EE, ID
13.	Mr. R.S. Gosawi	EE, MID, Beed
14.	Mr. S.A. Patan	EE, MID, Jalna
15.	Mr. N.Y. Patil	EE, MID, Chikli
16.	Mr. M.R. Misal	EE, ID, Buldana
17.	Mr. Joshi	Dy. E., Computor

C. AGRICULTURE UNIVERSITY (MAU), PARBHANI/DEPARTMENT

1.	Dr. N.Y. Palimkar	Assoc. Prof., NARP, MAU, Aurangabad
2.	Dr. G.S. Jadhav	-d0-
3.	Dr. C.P. Ghonsikar	Assoc. Director, Research MAU, Parbhani
4.	Mrs. S.M. Harode	Chief Coordinator & Prof. Home Science College MAU, Parbhani
5.	Dr. R.V. Nalamwar	Prof. Agronomy PKV, Akola
6.	Dr. V.K. Kolta	Supdt. Agri. School,
7.	M.G. Ingle	Agron., NARP, Buldana
8.	Mr. A.K. Patilkar	SDAO, RMIC, Amravati
9.	Mr. T.B.L. Dhare	SDAO, T&V, Mehkal, Dist. Buldana
10.	Dr. J.G. Kulche	SMS, T&V, Buldana
11.	Dr. N.Y. Palinka	Assoc. Prof, NARP, MAU, Aurangabad
12.	Dr. G.S. Gadhr	-do-
13.	Mr. Mandage	SMS, RMIC, Aurangabad

152

ANNEXURE III

TEAM SCHEDULE

DATE	TIME am/pm	LOCATION	ACTIVITY
6/10/91	am	USAID, New Delhi	Preliminary discussions with Mr. Maheshwari and Dr. Patil
	pm	"	Collection of reports and Team discussions.
6/11/91	am	"	Discussions with Dr. J. Grayzel, Dir.,NRM
	pm	"	Team discussions & study
6/12/91	am	"	Meeting with Mr. Bollinger, Dir,USAID and USAID officers
6/13/91) 6/14/91) 6/15/91) 6/16/91]	am/pm	"	Study and Team discussion
6/17/91	am	Bombay	Team arrives
	pm	"	Discussions with Secy. Irrig. CAD GOM and his team of officers.
6/18/91	am	Pune	Team arrives
	pm	"	(i) Discussions with LCU Team (ii) Discussions with CE, ID, Dir. DIRD and their team
6/19/91	am	"	Discussions with LCU TEAM
	pm	"	(i) Visited IPWRIG, Discussions with CE Pune and officers in charge of computer programs

DATE	TIME	LOCATION	ACTIVITY
			(ii) Discussions with Agronomy Expert of LCU
6/20/91	am/pm	Parunde	Visited Parunde MIS, Dist. Pune
6/21/91	am/pm	Sangvi(Shirwal) & Mulikwadi	Visited Sangvi(Shirwal) and Mulikwadi MIS of Dist. Satara, Region Pune
6/22/91	am	Puno	Discussions with Dir.DIRD
	pm	"	Discussions with CE, ID, Pune and his team
6/23	Team split. Mr. Haslem and Dr. Michael went to Aurangabad region and Dr. Weaver and Mr. Bhatnagar went to Nagpur region		
	(Dr. Weaver and Mr. Bhatnagar at Nagpur)		
6/23/91	am/pm	Nagpur	Team arrives
6/24/91	am/pm	"	Discussions with CE Nagpur, CE Amravati and their team
6/25/91	am/pm	Telhara Wadegaon	Visited Telhara MIS and Wadegaon MIS Dist. Nagpur, Region Nagpur
6/26/91	am/pm	Nagpur	Discussions with CE Nagpur and officers working on computer programs
6/27/91	am/pm	Wakeshwar	Visited Wakeshwar MIS witnessed Performance Test, Dist. Nagpur, Region Nagpur
6/28/91	am/pm		Visited Dattapur MIS Dist. Yeotmal Region Amravati.

154

DATE	TIME	LOCATION	ACTIVITY
6/29/91	am/pm		Team discussions
6/30/91	am	New Delhi	Team arrives
		(MR. HASLEM & MICHAELS AT AURANGABAD)	
6/23/91	am/pm	Puno/Aurangabad	Drive to Aurangabad
6/24/91	am	Aurangabad	Met Chief Engineer at Hotel visited WALMI-Aurangabad
	pm	"	Meet with Chief Engineer, Aurangabad Region
6/25/91	am/pm	Undangaon	Visited Undangaon MIS, Aurangabad Dist., Aurangabad Region.
6/26/91	am/pm	Hiwarsinga	Visited Hiwarsinga MIS, Beed Dist. Aurangabad Region
6/27/91	am/pm	Loni	Visited Loni MIS, Aurangabad Dist., Aurangabad Region
6/28/91	am/pm	Chikhali	Visited Katwada MIS, Buldhana Dist., Amravati Region
6/29/91	am	Aurangabad	Meet with AG. Officers, Womens Expert, and ID Officers at Chief Engineers Office
6/29/91	pm	Aurangabad	Visited Jaiakwadi Dam
6/30/91	am/pm	Aurangabad/Delhi	Travelled by air to New Delhi (plane was 9 hrs. late)
7/1 to 19	am/pm	New Delhi	Report Writing

ANNEXURE IV-A

PARUNDE MIS

(Visit on 6/20/91)

General

The Parunde Minor Irrigation Scheme (Tal.Junnar, Dist. Pune), situated on the North west border of Pune region on the western slope of Sahyadri range, is approachable by Pune-Nasik state highway up to Narayangaon and on via the historic Shivneri fort at a total distance of 90 kms. from Pune. The project was sanctioned by the GOM in 1980 but major activity started only in 1985 when it was included in MMIP on 6/11/85. It cleared the B.M.IV stage on 12/3/90.

The area had fairly well developed well irrigation and is close to World Bank assisted Kukedi major irrigation Project. Farmers in vicinity have been growing vegetables and flowers for Bombay market. The farmers of Parunde MIS have therefore an exposure to irrigated agriculture.

One typical feature of Parunde was that farmers in Submergence were opposing construction of the dam and agreed only after the ID and the command farmers agreed to reserve water from out of storage for irrigating 60 Ha of land on the periphery of the reservoir by lift. These farmers have already installed six lift irrigation units and water drawn by them is being controlled on volumetric basis. The units are run by cooperative societies of 10 to 15 farmers in each unit.

The ASR of the project was approved for Rs.4.77 million. The revised cost was indicated to be Rs.9..9 million against which an expenditure of about Rs.8.0 million has since been incurred..

Important Salient Features

The important salient features of the project are as under:

Catchment Area	7.38 Sq.km
Average Annual Rainfall (50% dependability)	652 mm.
Yield	1.076 Mm^3
Gross Storage	0.939 Mm^3
Dead storage	0.70 Mm^3
Live Storage	0.869 Mm^3
Gross Annual Use	1.0194 Mm^3
Submergence	16 Ha
Length of Dam	290 M
Maximum Height	20.03 M
Length of Canal(Right Bank only)	2.5 km.
Designed Discharge at head	0.165 cumecs
C.C.A.	212 Ha
I.C.A.	172 Ha
Number of Chaks	10
Irrigation Intensity	80%

Dam And Conveyance System

The Evaluation Team went round the dam, the irrigation sluice and the spillway. The first filling of the reservoir was done in 1989 monsoons and irrigation is being provided since rabi crop of 1989. The dam had filled up due to a heavy down pour about ten days back. The Team found that the dam and its appurtenant works had been neatly constructed and were in good state of repairs. A hydromet station has been installed near the right flank on down stream side. All instruments were working and observations were being taken regularly. The Team then walked along the canal. It had sustained minor damages which were reported to be on account of high intensity of the last downpour.

Part I Works (Field Channels)

The Team then walked into three chaks along the field channels. While the structures and turnouts were found to be in position, the earthen section of field channels was in a damaged condition. In some reaches the section was practically non-existent. It was stated that the field channels were badly damaged during the last heavy rains and will have to be extensively repaired by the farmers before they can draw water. If such a demand arises during kharif stress period, the repairs shall have to be done before that. The Team felt that such a damage to field channels, when drainages have by and large been excluded, needs to be looked into. While some repairs to field channels from season to season would always have to be done by farmers, reconstruction of the earthen section every time may be both uneconomical and time consuming. The land is highly undulating but quite a bit of land shaping has been done by the farmers' themselves. This effort is changing the look of the area quite fast. The two demonstration chaks were reported to be Nos. 5 & 8..

Farmers' Participation

There are 167 farmers in flow area and 60 in lift area. Their holdings range from 0.5 to 1.5 Ha. The chak sizes vary from 1.6 Ha to 22.0 Ha. Outlet committees have been constituted for all the ten flow chaks as also for six lift areas on periphery of submergence. The Team met around 30 farmers of whom three from flow areas and one from lift area acted as their spokesmen. There was a problem of reshuffling of areas between chaks 6 & 7. This is being sorted out by the ID in consultation with farmers. The farmers' wanted the alignment of field channel on chak No-2 to be modified. The ID officers promised to discuss the problem with outlet committee and sort it out. The farmers were generally satisfied with the working of committees and have

accepted the RWS for field application. They however expressed some doubts about a Tank level committee being able to manage the total affairs including maintenance. They would further discuss the

matter amongst themselves but such a thing may be possible only after two years or so. Other demands put forth by farmers' to the Team were:

(i) AU staff support available to them must be continued for at least another two years. They have found the advice and guidance very useful but they need it further as they want to switch over to high value crops and introduce drip irrigation. If this support is withdrawn earlier, the adoption of modern agricultural practices will come to a standstill. They wanted a pilot study to be taken up for drip irrigation both for flow and lift areas at Parunde.

(ii) They wanted GOM Assistance for land-levelling both for flow and lift areas on the lines given to tribals who get 100% subsidy.

(iii) Rehabilitation norms as applicable to major projects should be made applicable to minor schemes as well.

(iv) It should be made mandatory for ID to provide employment to at least one member of such families of oustees who have been rendered landless due to submergence.

(v) An approach road should be constructed up to the villages Parunde and Vaishnav wadi.

Land Acquisition

Of the oustees, there were four cases where families were rendered landless. Two families repurchased land at higher levels above the reservoir level and are availing of lift irrigation facilities. Out of the other two, one has been employed

by the ID as chowkidar and the other as a laborer. The Team would recommend that their employment should be continued to provide them with means of subsistence. It is understood that no rehabilitation was involved in the project.

Observations

The Team made the following observations.:

(i) The development of irrigation on this MIS has been creditably fast. Against Rabi irrigation of 137 Ha as per project, the actual irrigation in Rabi 90-91 was 131 Ha and another 17 Ha by private wells.

(ii) Yields were reported have increased two to three times.

(iii) Vegetables were grown only by farmers who had well water available to them.

(iv) The water table down stream of the dam and in command has come up considerably and a number of new wells have been dug both in command as well as on the left bank of the nalla. With good availability of ground water this needs to be further encouraged. The left bank wells (out of command) have developed about 19 Ha of land.

(v) The cultivators are not taking water in the night and RWS had to be revised for 12 hour irrigation per day. In early stages this may work but the canal capacities would run short if 24 hours irrigation habit is not inculcated. This should be done without waiting for full development as things may go out of control later.

(vi) The Team appreciated the farmers' keen-ness for continued technical assistance for improved agriculture and recommends that this be continued for another three years

(vii) Computerized operation plan was partly used on the project. The Team recommends that Technical Assistance for this should continue for a further period of three years to bring about necessary refinements and make its use a normal successful feature.

(viii) The employment of two oustees by the ID should be continued on a permanent basis to provide these families with means of subsistence.

SANGVI (SHIRWAL) MIS

(Visited on June 21, 1991)

General

The Sangvi (Shirwal) Minor Irrigation System is located in Khandala Taluka of Satara district. The construction of the Project commenced in 1981. The dam and headworks were completed in May 1988. By January 1991 about 75% of the distribution system was completed and 30% of the Part I works were also completed. Performance test as laid out under Bench Mark III was done in February 1991. Irrigation activities in the command area commenced in rabi 1990-91.

Important Project Features

Reservoir catchment area	46.50 sq.km
No. of turnouts	134
Reservoir storage	1.344 Mm^3
No. of drop structures	16
Dead storage	0.443 Mm^3
Cross drainage structures	2
Live storage	0.89145 Mm^3
Division boxes	28
Reservoir submergence	31.68 ha
Length of earth dam	850 m
Maximum height of dam	18.00 m
Canal length	5.00 km
Design discharge at head of canal -	
No of chaks	15 (11 completed)
CCA	218.50 ha
ICA	174.8 ha
Project cost (as of June 1991)	Rs.44.27 M
Principal crops grown	Gram, sorghum, wheat, groundnut.

Reservoir and Distribution System

The Team travelled across the length of the dam and observed the dam, spillway and irrigation sluice. The reservoir was full to the sill level. The Team visited the pipe aqueduct across the spill channel to the right bank. The aqueduct which was supposed to be in cutting is exposed and there should be some concern regarding the safety of the pipeline itself for being struck by debris moving downstream. The Team then proceeded to visit some of the chaks. The water conveyance and distribution structures were rather well constructed, though there is scope for improvement. At one point the canal bank was eroded due to a breach caused by the runoff water which had accumulated in the adjoining field. There was no attempt on land levelling or shaping and there was no provision for the safe disposal of excess runoff resulting from monsoon rains. It was observed that there is scope for improving the location of a few of the turnouts to obtain a better coverage of the command area.

Farmer Participation

The farmers at Sangvi Shirwal were progressive and had been using improved farm implements including two-bowl seed drills and adopting high yielding crops varieties. The Team observed the farmers sowing groundnut in well prepared seed beds. The need for proper land development was felt by the farmers who were seeking proper technology, equipment and financial assistance to do the job. The on farm-development plan of Bench Mark II had shown the drainage ways in the topographical map of the chak. However, there was no effort in taking up the work or providing any assistance to the farmers in this aspect.

ANNEXURE IV-C

MULIKWADI MIS

Visited on June 20 1991

General

The Mulikwadi Minor Irrigation Scheme consists of an earthen dam across a local nala near the Village of Mulikwadi in Satara District, Maharashtra. About 40% of the embankment had been competed when the scheme was brought under the USAID project in 1985 as having completed Bench Mark I. Bench Mark II was finished in Feb.1988, Bench Mark III in Feb 1990 and Bench Mark IV in April 1991.

The project is administered under the Sangli Irrigation Division.

Important Salient Features

Catchment Area	27.75 Sq.Km.
Culturable Command Area	304.00 ha.
Irrigable Command Area	219.00 ha.
Area Under Submergence	61.60 ha.
Average Annual Rainfall	473 mm.
Gross Storage	1.655 Mcum.
Live Storage	1.353 Mcum
Dead Storage	0.302 Mcum
Length of Dam	1200 meters
Maximum Height of Dam	13.80 meters
Discharge at Head	358 lps.
length of Main Canal	2.95 km.
Intensity of Irrigation	87%
Cost of the Project	6.418M.(revised)
Economic rate of Return	11.84%
Cost per Ha. of ICA	29,300 Rs/ha.
Number of Chaks	19
Number of Outlet Committees	19

Climatic Conditions

This tank is located in the drier climatic area of the State. The average rainfall is only 473mm with 34% (159mm) falling in the month September. In all but the very best rainfall years kharif crops will experience water stress at sometime during the growing season. In the bad years, (avg. 306 mm, range 200 mm to 378 mm) which seem to occur about once every five years, the kharif crop will be under severe water stress sometime during the season. This is most likely to occur during the months of July, August and October. It is quite predictable that there will be a demand for kharif season irrigation in Mulikwadi in almost all years. This will be a special challenge to provide the data necessary to operate the MIS system to keep tract of water deficiencies in both the kharif and rabi seasons

Agriculture

Although some rabi irrigation(41.20 ha) took place last year, the 1991/92 cropping season, providing that the reservoir fills, will be the first full year of operation. The cropping pattern that is recommended in the project area, according to soil type, is kharif bajara or jowar and rabi jowar or millet, kharif groundnut or bajara followed by wheat gram or jowar, or kharif groundnut, onion or maize followed by wheat gram or sunflower in the rabi season.

There are at least ten hectares that are irrigated with wells immediately adjacent to the project area. Likewise there are wells within the project area. The evaluation team observed a farmer in the shadow of the dam irrigating vegetables using an underground pressurized pipe. He was using border furrows with small basins. He appeared to be doing an excellent job of applying water.

Condition of the Works

The dam is 1200 meters long. The evaluation team approached the site from aside the waste weir. There was a disturbing amount of drainage from under the weir. Down below, perhaps about fifty or sixty meters a new dug well was in the process of being completed. There was some question that this might ultimately effect the integrity of part of the damn. The main canal and field channels are very well constructed.

Discussions with Cultivators

It was late in the day when the team reached Mulikwadi. A small group of cultivators were waiting at the end of the dam. A number of them were chairmen of an outlet committee. As at the other sites, all of the cultivators reported they were involved with the layout of the water courses and that the irrigation department had been responsive to their suggestions. The team walked along a number of the watercourses and noted that a good bit of land shaping would be required and that some of the runs in the fields would be very long.

Water was running in the main canal from a leak in the dam outlet seal which has been scheduled to be repaired as soon as is feasible. We followed the water down the watercourse into which it was being diverted and came upon a small paddy nursery and a dug well. The water table was at about three meters. It was in a low lying area and is being used to irrigate both sugarcane and a very small paddy plot. Several farmers happened by and we asked about the irrigation system and the outlet committees. They commented that they saw no trouble with organizing to clean the watercourses "we know the size of everyone fields and they will supply labor on that b a s i s . "

ANNEXURE IV-D

UNDANGAON MIS

(Visited on June 25, 1991)

General

The Undangaon Minor Irrigation System is located near village Undangaon in Sillod Taluka of Aurangabad district. The construction of the scheme was started in 1983 and completed in June 1990. The irrigation activities commenced in July 1990.

Important Project Features

Reservoir catchment area	7.04 sq.km
No. of turnouts	134
Average annual rainfall	704.05 mm No.
of drop structures	16
Reservoir storage	0.6495 Mm^3
Cross drainage structures	2
Dead storage	0.0815 Mm^3
Division boxes	28
Live storage	0.5680 Mm^3
Reservoir submergence	36.12 ha
Length of earth dam	690m
Maximum height of dam	9.09m
Canal length	7.970 km
Design discharge at head of canal	0.09 Cumecs (95.97 LPS)
No. of chaks	12
CCA	140.58 ha
Project cost	Rs.4.4 M
Principal crops grown	Gram, sunflower, wheat
Irrigation intensity	75%

Reservoir and Distribution System

The team travelled across the length of the dam and observed the spillway and irrigation sluice. The reservoir was full up to the crest level on June 25, 1991, the day of visit of the team. There was overflow through the spillway a few days earlier. The team visited the water distribution system and the command area of

Chak No.4. In Chak No.4 the on-farm structures (drops, division boxes, turnouts, cross drainage works, etc.) were well constructed. However, one of the drop structures had silted up, probably due to its improper location. The field channel required maintenance as it had nearly silted and the embankment eroded . It was not in a condition to receive irrigation water in case of an immediate demand for protective irrigation in the late kharif season. The ID officials and the farmers were confident that the maintenance of the field channels will be carried out by the beneficiary farmers well before the rabi sowing commences. However, the team is of the view that there would be considerable time lag in case the necessity for protective irrigation of the kharif crop is felt. The inspection group then travelled to see the main canal in deep rock cut between outlets 4&7. The minor canal supplying water to outlets 5&6 which had a discharge of 37 liters per second was well maintained, as compared to the field channels originating from the regular outlets, even though these channels were also nearly of the same capacity.

Farmer Participation

The farmers at Undangaon seemed to be well organized in all the 12 chaks and were quite satisfied with the new project which ensured the delivery of water to all the outlets, as per the proposed operation plan. The spokesman of the farmers was a former medical practitioner who took up farming. The farmers were generally satisfied with the availability of inputs from the regular supply sources of the department of agriculture. However, the support to the farmers from the T&V system of the Department of Agriculture was weak. The VEW of the Marathwada Agricultural University was available. He had provided fairly good support to the farmers in improved farming practices.

HIWARSINGA MIS

(Visited on June 26, 1991)

General:

The Hiwarsinga Minor Irrigation System is located in the Patoda Taluka of Beed District in the Aurangabad region of Maharashtra about 170 Km southeast of Aurangabad. The project was administratively approved by Government in 1982 but no major activity was started until it was included in MMIP in 1985. Compliance with BM-IV was authorized on 11/24/90.

Important Project Features:

The more important salient features of the Hiwarsinga MIS are given as follows:

Reservoir Catchment Area	13.3 sq Km
Average Annual Rainfall	698.5 mm
Reservoir Storage	1.416 Mm^3
Dead "	0.147 "
Live "	1.279 "
Reservoir Submergence	46.9 ha
Length of Dam	950 m
Maximum Height of Dam	13.75 m
Canal Length (Right side only)	5.4 Km
Design Flow at Head of Canal	0.238 cumec
Number of Chaks	14
CCA	286 ha
ICA	260 ha
Project Cost	Rs 14.5 M
Irrigation Intensity	100%

Reservoir and Irrigation Distribution System:

The reservoir at the Hiwarsinga MIS has only received partial filling so far this year. The dam was completed in 1988 and has filled each year since that time. The team traveled across the length of the dam by vehicle to observe the spillway and irrigation sluice. There is noticeable seepage at the lower reaches of the downstream toe. Walked across the approach area to look at the irrigation sluice on the opposite or high side of the spillway. Here the approach channel to the sluice was observed cut in deep rock across the approach to the spillway weir. The Main Canal is also cut in deep rock in its initial reaches and sloughing of loose rock into this channel should be removed. The meteorological station for this scheme is also on this side of the embankment.

D. Part I Works (Chaks):

The inspection group then traveled to the command area where discussions were held with farmers and the field channels of Chak No. 7 was inspected along with the parallel Main Canal. The field channels were well constructed and of the type of larger cross section that is more normal for water courses serving farmers in the Chak. The land slope at Hiwarsinga is flatter than other MIS observed and the soils are shallow and erosive. Some channel cutting was observed below a number of the structures and lowering of the downstream apron of these structures to form a water cushion was suggested.

E. Farmer Participation:

The farmers at Hiwarsinga MIS seem to be well organized (there are 14 chaks). They and even have a farmer spokesperson for the group. They are not opposed to a Tank Committee but want to think it over. The farmers also said that they do not have a problem irrigating with a flow of 30 lps. The support from the Ag. Univ. and Dept. of Agric. is weak. The VEW lives over 100 km from Hiwarsinga and doesn't visit the Project often.

LONI MIS

(Visited on June 27, 1991)

General

The Loni Minor Irrigation System is situated near Loni village in Khultabad Taluka of Aurangabad district. The construction of the scheme was started in 1984 and completed in June 1990. The irrigation activities commenced in October 1990.

Important Project Features

Reservoir catchment area	5.83sq.km
No of turnouts	134
Average annual rainfall	754.05 mm
No. of drop structures	16
Reservoir storage	8.583 Mm^3
Cross drainage structures	2
Dead storage	0.0064 Mm^3
Division boxes	28
Live storage	0.8519 Mm^3
Reservoir submergence	30.00 ha
Length of earth dam	376 m
Maximum height of dam	16 m
Canal length (Left Bank)	2.52 km
Design discharge at head of canal	0.164 Cumecs (164 LPS)
No. of chaks	14
CCA	255.05ha
Project cost	Rs. 5.035M
Principal crops grown	Gram, sunflower, wheat
Irrigation intensity	69%

171

Reservoir and Distribution System

The Team travelled across the length of the dam and observed the spillway, the irrigation sluice, main canal and irrigation structures. The reservoir was full up to the crest level on the day of visit of the team. The Team visited the water distribution system and the command area of selected chaks. At the head reach one of the farmers had made extensive levelling of his field to bring more of his land under the command of MIS. The Team visited some of the cross drainage works. Though the structures were satisfactory from the cross drainage view point, the aspect of soil erosion and gully formation around a structure were not given the required attention. In one case a check dam structure constructed to support the pipe conduit of a culvert served as an excellent soil saving dam for the fields upstream. Though the water conveyance system was working well, the fields required proper land shaping to distribute the water efficiently in the different fields of the command area of the outlets. No provision for drainage was made. Field channel maintenance was poor. At one point there was a major breach and the water was overflowing and flooding the fields.

Farmer Participation

The farmers were satisfied with the performance of the water distribution system. They were also satisfied with the assistance provided by the VEW of MAU (Agrl. University). There was good interaction between ID officials and the farmers. The farmers, however, were looking for support in land development works. The importance of drainage had not yet been appreciated by them. There was also demand for water to irrigate cash crops like sugarcane which the ID officials could not agree to.

KATWADA MIS

General

The Katwada Minor Irrigation System is located near village Khatwada in Deulgaon Raja Taluka of Buldhana District. The construction of the scheme was commenced in October 1990. The irrigation activities commenced in October 1990.

Important Project Features

Reservoir Catchment Area	15.02 sq. mi.
Average Annual Rainfall	720 mm
Reservoir Storage	1.869 Mm^3
Dead Storage	0.163 Mm^3
Reservoir Submergence	63 ha
Length of Earth Dam	5.46 km
Length on Left Bank Canal	3.35 km
Design Discharge at head of:	
a) Right Bank Canal	0.199 cumecs (199 lps)
b) Left Bank Canal	0.144 cumecs (144 lps)
Number of Chaks	31
CCA	372 ha
ICA	288 ha
Project Cost	Rs. 12.80 M
Principal Crops Grown	Wheat, Gram, Cotton Sunflower
Irrigation Intensity	77 percent

Reservoir and Distribution System

The Team travelled across the length of the dam and observed the spillway and the irrigation sluices on the right bank. The reservoir was only partly filled on the day of the visit of the

Team. The Team visited the water distribution system and the command area of the right bank canal system. At the head reach of the right bank canal one of the outlets which was originally provided was later closed by the Irrigation Department on the request of the farmers since its command area which was close to the reservoir was getting waterlogged. An alternate outlet with an equivalent command area caused by the closure of the outlet. The Team observed wide variations in the size of land holdings of different chaks. The number of farmers in a chak varied from two to eighteen. Command area of chaks varied from 2.55 ha to 29.93 ha. The main canal, outlets and structures were in good condition while the field channels required maintenance. At one of the points the turnout was located a at lower point from the head end of the field which left about one-third of the field area outside the command of the canal system. The Team felt that if the alignment of the field channel was modified this lacuna could be removed.

Farmer Participation

The Team met the farmers in a formal group meeting at the village school. In general, the farmers appreciated the project and were convinced of its benefits. Some farmers had problems in getting water to their fields. The involvement of PKV, Akola was effective. The T&V wing of AD was also extending assistance to farmers of the scheme. However, there was no contribution from the soil conservation wing of AD. Some farmers mentioned that the estimates on land levelling given by the soil conservation wing of AD. Some farmers mentioned that the estimates on land levelling given by the soil conservation wing was higher was higher than the cost of the land itself The formers were also not convinced of the type of levelling work proposed by the soil conservation staff. There was good understanding between the staff of ID, AD and AU.

TELHARA MIS

(Visit on 6/25/91)

General

Telhara Minor Irrigation Project is situated in Higna Taluka of Nagpur District. The project is 15 kms. from Nagpur approachable by Nagpur - Wardha Highway upto 10 kms. and a 5 km stretch of village road off-taking from the highway. The project was originally sanctioned by GOM in 1977 in EGS but the construction came in full swing only after it was included in MMIP in 1986. It was cleared for Bench Mark I in 12/86 and went through Bench Mark IV Stage in January 91. During its total construction period, the project generated 4814 man-months of employment of which about 1150 man-months were of pre-MMIP period.

At the time of ASR, the cost was indicated as Rs.3.543 million. The revised cost, however, is Rs.6.281 million. An expenditure of Rs.5.743 million has been incurred upto May 91. The project is situated close to Nagpur town and had remained in construction stage for a fairly long time. Some lands in command are owned by non-agriculturists from Nagpur. The absentee land-lordism was one of the problems coming in the way of quicker development of irrigation. With assured water supply lands are now being broken. It is hoped that the development may perhaps be superior because of comparatively more affluent Nagpur based land owners.

Salient Features

The important salient features of the project are as follows:

Catchment Area	3.885 Sq.kmAverage
Annual Rainfall (50% dependability)	1030 mm
Yield (50% dependability)	1.382 Mm^3
Gross Storage	0.926 Mm^3
Dead Storage	0.042 Mm^3
Live Storage	0.684 Mm^3
Annual Utilization	0.926 Mm^3
Area under submergence	39.27 Ha
Length of Dam	786 m
Maximum Height of Dam	10.06 m
Length of Main Canal(Left Bank only)	3.7 km
Designed Discharge	175 lpsNumber of
Chaks	12
C.C.A.	163 Ha
I.C.A. 130 Ha	
Intensity of Irrigation	80%

Dam & Conveyance System

The gorge filling was done before 1990 monsoons and the tank received full water. After rabi irrigation of 90-91 and some hot weather vegetables crops, water was left over in the tank. It was partially filled on the date of visit. The Team went round the dam, irrigation sluice and its flush bar type surplussing arrangement. The irrigation sluice has a chamber over it and is fixed with a rolling shutter. A stage water level recorder is installed there which was working. The dam has a toe filter with a toe drain. The drains have V notches fixed for keeping record of seepage from both flanks and another V-notch to measure combined seepage discharge. The construction quality of dam and its appurtenent works appeared to be good with neat lines, levels and profiles.

The Team then walked along the canal and found that the construction had been done in a workman like manner with robust structures and lining wherever necessary. All structures and profiles had full supply level prominently marked on them. The Team noticed that in an old well down-stream of the dam, the ground water level has risen by about 3 meters. Looking to this, some other wells in the command were seen. The ground water level had gone up by about 1-1/2 meters about 1km down stream of the dam. It was stated that during monsoons the water level rises further and comes to about a meter below ground level. The fast rise of water table needs to be closely watched. The off take from old wells and new ones which have been dug should also be broadly monitored. New wells have come up on right bank also. The chak sizes vary from 6.05 Ha to 20.53 Ha. and each is served by an outlet releasing 30 lps in the field channel.

The Team visited the meteorological station also and found all instruments working. Regular observations are being taken. Time of observation should be kept the same as prescribed by IMD. The fisheries Dept. had introduced fingerlings in the dam and are letting out harvesting to cooperative societies.

Part I Works (Field Channels)

The Team moved in the commanded area along field channels. The field channels were done in a good manner and had been lined, in vulnerable reaches, with stone pitching as per observations during performance test. Pre-cast structures have been used on the field channels for falls, division boxes and turn-outs. These had been properly fixed. The area being less undulating, field channels were in good shape and adequate by any standards.

Farmers' Participation

The command consists of a narrow strip along the nalla and has been divided in 12 chaks. Outlet committees for all chaks are functioning. There is also a Tank level committee. The farmers had no difficulty in getting organised and following RWS schedules in the last Rabi season. The Tank committee also appeared enthusiastic to the idea of taking over full control. They however did not seem to understand full implications of maintaining the canal. The ID was advised to have a meeting with them and explain full details of the concessions that will be available to them, maintenance funds that will be passed on and the whole gamut of the proposal. They should know full details to be able to take a decision.

Cultivators were quite enthusiastic to produce vegetables and similar items that have a ready market in Nagpur. There are 17 wells in the command and conjuctive use is likely to develop fast. It may, infact become necessary looking to the rise in water table. The area was traditionally producing vegetables for Nagpur market from well irrigation even in pre-project stage. Some wells have come up in areas which are out of command. The farmers were keen to continue getting advice on modern agriculture techniques and appropriate cropping pattern. The Team recommends that this technical assistance on agriculture should continue for another three years.

The computorised operation M.I. model was made available to the project before Rabi 90-91 and PIP was finalised on that. Further scheduling, however, could not be done through this due to subsequent technical flaw in the soft ware. It is a very scientific and useful aid in application of water and can improve efficiency and production considerably. It has to be allowed to function so that the ID/AD staff as also the cultivators assimilate it. The model would also require considerable fine tuning before really workable solutions are put on it. Results of this type can

178

not be achieved in one year and the Team recommends that necessary Technical Assistance for this should continue for another three years.

Land Acquisition

No rehabilitation was said to be involved on the project. On inquiry, the Team was informed that there were perhaps two or three cases where the farmers of submerged area were left with no land. They were reportedly given jobs by the ID on the dam and canals. The Team feels that the position be verified and employment to at least one member of such a family provided by the ID to enable them to sustain themselves.

Observations

(i) Development of command to the tune of 65% with the problem of absentee landlords is considered as a good achievement.

(ii) The ultimate cropping pattern is likely to be different compared to the one contained in the project depending upon marketability of high value crops. The availability of ground water will hasten this process by conjunctive use. It is felt that the AU may have to review the proposed cropping pattern. The farmers were very keen that the guidance and advice on modern Agriculture techniques and suitability of various irrigated crops available to them under the project must continue till a stable pattern is established. The Team recommends that this technical assistance to farmers should be continued for three years more.

(iii) The computorised operation model for field application of water has not been put to use so far. It is going to be extremely useful and will result in economy of

water as also in substantially increasing yields. The model will also need considerable fine tuning and the ID/AD staff as well as farmers will take some time to get used to it. Its impact will take atleast three years to be understood and then alone it will become a part of the system. It is strongly recommended that Technical Assistance on this should be continued for another three years.

(iv) Conjunctive use of water should be encouraged and water table in the command kept under constant watch particularly in view of its sizeable rise.

(v) The farmers are at present not taking water at night and the RWS had to be revised for a canal running of twelve hours a day. With the fast development of command, the canal capacity is going to run short if 24 hours irrigation culture is not inculcated. The rotations be immediately switched over to 24 hours without waiting for full development as things may go out of control later.

(vi) The number of farmers who were rendered landless due to submergence be verified and one person from each such family provided suitable job to enable them to subsist.

(vii) The project has solved drinking water problem of some of the villages which is a very re-deeming feature.

(viii) Some wells have come up in areas which are out of command. This is an unaccounted for benefit of the project which should be taken into account.

(ix) Income from fisheries development should also be taken into account.

180

WADEGAON MIS

(Visit on 6/25/91)

General

Wadegaon Minor Irrigation scheme is located about 25 kms. from Nagpur on Nagpur - Umrer highway. The scheme is in Umrer Taluka of Nagpur district. The scheme was sanctioned by GOM in 1981 but work was started under EGS only in 1985. It was however taken under MMIP in January 1986. It cleared Bench Mark I in Dec.86 and Bench Mark IV in May 91. During the total construction period, the project created about 9530 man-months of employment of which about 1690 man-months were of pre MMIP period.

As per ASR, the project cost was indicated as Rs.6.19 million but the revised cost was said to be Rs.13.30 million. An expenditure of Rs.11.29 million has already been incurred up to May-91. Unlike other projects visited by us, the command here had no tradition of irrigated agriculture as water table was almost 10 to 13 meters below ground level.

Salient Features

Catchment Area	5.176 sq.km.
Average Annual Rainfall (50% dependability)	1149 mm
Yield (50% dependability)	1.9371 Mm^3
Gross Storage	1.537 Mm^3
Dead Storage	0.06 Mm^3
Live Storage	1.477 Mm^3
Annual Utilization	1.937 Mm^3
Area under Submergence	59.36 Ha
Length of Dam	1323 m
Maximum Height of Dam	9.7 m
Length of canal(left bank only)	5.62 km
Length of minors (three)	3.94 km
Designed discharge at head	506 lps.
Number of chaks	40
CCA	358 Ha
ICA	285 Ha
Intensity of Irrigation	100%

Dam & Conveyance System

The dam was completed before monsoons of 1990 and had stored full water. It had only partial storage at the time of visit of the Team. The Team visited the dam, spillway and the sluice. The quality of construction appeared very impressive on the dam and its appurtenant works like the clear overall weir, intake structure, filter toe and toe drain. The sluice chamber, duly protected with a rolling shutter, had a stage water level recorder installed which was working. The toe drain had V-notches to measure discharges from both flanks and another one to measure combined discharge.

The Team walked along the canal part of the way and then drove along it. It had been lined in some reaches and gave a very healthy look. The structures were very well done and had the designed FSL prominently marked on them. The Team was told that during operation test for Bench Mark IV, it was found that discharge observations at different locations were not matching. The trouble was traced to the Cut Throat Flume in head reaches which had been wrongly calibrated. The snag was discovered after quite a few sections were isolated and re-examined. The calibration was finally corrected. This is being mentioned to high-light one of the practical applications of this test which enabled the ID to ensure that the system performs as per standards.

The Team visited the meteorological station installed near the dam and found that all the instruments were working and regular observations were being taken. The fisheries department have introduced fish in the tank and are harvesting them through cooperative societies.

Part I Works (Field Channels)

The Team visited the commanded area and walked along some of the field channels. The land in command is flatter compared to other projects visited by the Team. The water courses were found

to be in a very good condition and the pre-cast structures used on these had been properly embedded. They had withstood the performance test without any signs of outflanking. The over all condition of field channels was really good.

Farmers' Participation

There are in all 40 chaks in the command of which 19 are on main canal and 3, 7 & 6 on minors 1,2 & 3 respectively. The chak sizes vary from 1.32 Ha to 14.00 Ha with number of farmers varying from 1 to 5. Outlet committees on all the chaks are in existence. The farmers informed the Team that they have been involved in layout of canals and field channels from the start and such modifications as were suggested by different outlet committees were discussed by the ID officers with them before being finalized. The farmers had found the committees useful and they have adopted the RWS without facing any problems except that water was taken only during day time by them.

This area was growing rainfed chilies and jowar in pre-project stage. Introduction of irrigation has prompted a major shift in the cropping pattern to soya beans in kharif and wheat in rabi season. In-experienced, as the farmers were in irrigated agriculture, there was a real need for assistance. This need appears to have been met by the VEW from Agriculture College Nagpur.It was felt that the VEW had developed a very good rapport with the farmers. He has also been instructing them in border furrow irrigation techniques. They need continued advice on agricultural inputs of the University which in the opinion of the Team should continue for another three years.

The computerized operation MI model was made available to the project before rabi 90-91 and PIP was finalized on that. Further scheduling, however, could not be done through this due to subsequent technical flaw in the soft ware. It is a very scientific and useful aid in application of water and can improve

efficiency and production considerably. It has to be allowed to function so that the ID/AD staff as also the cultivators assimilate it. The model would also require considerable fine tuning before really workable solutions are put on it. Results of this type cannot be achieved in one year and the Team recommends that necessary Technical Assistance for this should continue for another three years.

Land Acquisition

No rehabilitation was said to be involved on the project. On inquiry, the Team was informed that there were perhaps two or three cases where the farmers of submerged area were left with no land. They were reportedly given jobs by the ID on the dam and canals. The Team feels that the position be verified and employment to at least one member of such a family provided by the ID to enable them to sustain themselves.

Observations

(1) Development of command to the tune of 86% in the very first rabi season of 90-91 is considered as a very good achievement.

(2) The ultimate cropping pattern is likely to be different compared to the one contained in the project depending upon marketability of high value crops. The availability of ground water will hasten this process by conjunctive use. It is felt that the AU may have to review the proposed cropping pattern. The farmers were very keen that the guidance and advice on modern Agriculture techniques and suitability of various irrigated crops, available to them under the project must continue till a stable pattern is established. It is recommended that this technical assistance to farmers should be continued for three years more.

(3) The computerized operation model for field application of water has not been put to use so far. It is going to be extremely useful and will result in economy of water as also in substantially

184

increasing yields. The model will also need considerable fine tuning and the ID/AD staff as well as farmers will take some time to get used to it. Its impact will take at least three years to be understood and then alone it will become a part of the system. It is strongly recommended that Technical Assistance for this should be continued for another three years.

(4) Conjunctive use of water should be encouraged and water table in the command kept under constant watch.

(5) The farmers are, at present, not taking water at night and the RWS had to be revised for a canal running of twelve hours a day. With the fast development of command, the canal capacity is going to run short, if 24 hours irrigation culture is not inculcated. The rotations be immediately switched over to 24 hours without waiting for full development as things may go out of control later.

(6) The number of farmers who were rendered landless due to submergence be verified and one person from each such family provided suitable job to enable them to subsist.

(7) The project has solved drinking water problem of some of the villages which is a very re-deeming feature.

(8) Some wells have come up in areas which are out of command. This is an unaccounted for benefit of the project which should be taken into account.

(9) Income from fisheries development should also be taken into account.

ANNEXURE III-J

WAKESHWAR MIS

(Visit on 6/27/91)

General

Wakeshwar Minor Irrigation scheme is located at 23 kms. from Nagpur with a 3 kms. village road taking off from the 20th kilometer of the Nagpur-Wardha highway. The scheme is in Nagpur Taluka of Nagpur District. The project was sanctioned by the GOM in 1983 under Employment Guarantee Scheme (EGS). It however gained momentum only in 1987 when it was included in the MMIP. The work was completed and cleared BM IV in March 1991. During the total construction period, the project created about 14800 man-months of employment of which about 600 man-months were of pre MMIP period.

As per ASR, the project was estimated to cost Rs.7.26 million but the revised cost was indicated to be about Rs.14.3 million. An expenditure of Rs.13.5 million had already been incurred up to May 91. Amongst MI Schemes close to Nagpur, the approach of this project is more convenient. The advantage of this proximity has been a quicker development of easily marketable vegetables. It has, at the same time, resulted in absentee land-lordism with some Nagpur based non-agriculturists holding lands. The process of sowing these as well as some more lands, which are out of command but now have a reliable ground water supply, has since started

The Team had requested for a part performance test to be conducted on one of the projects and this was the project selected for the same due to availability of storage. A report on the test has been incorporated in subsequent paragraphs.

Salient Features:

The important salient features of this project are:

Catchment Area	6.37 sq. k.
Average Annual Rainfall (50% dependability)	1120.39 mm
Yield (50% of dependability)	2.2551 Mm^3
Gross Storage	2.145 Mm^3
Dead Storage	0.0713 Mm^3
Live Storage	2.074 Mm^3
Annual Utilization	2.2334 Mm^3
Area under submergence	96.35 Ha
Length of Dam	1431 M
Maximum Height of Dam	10.5 M
Length of Main Canal(right bank only)	4.8 km
Length of two minors	0.925 km
Designed discharge at head	315.5 lps.
Number of chaks	18 (one is lift irr. chak)
CCA	263 Ha
ICA	254 Ha
Intensity of Irrigation	100%

Dam & Conveyance System

The dam was completed before monsoons of 1990 and stored water upto its full capacity. It had only partial storage this year. The team visited the dam, spillway and the irrigation sluice. The dam and its appurtenant works have been constructed in a professional manner. The clear overfall spillway was also well constructed. The irrigation sluice chamber had a stage water level recorder installed which was working. The dam has a filter toe with a pitched toe drain from both flanks. There were V-notches to measure seepage discharges from both flanks and another to measure the combined discharge. Seepage flow in the toe drain was nominal.

The Team walked along the canal and drove part of the way upto 3.185 km. of the main canal. The canal system was found to have been neatly constructed. All structures and profiles had FSL marked prominently on them and were giving a healthy look. Some reaches with more than normal discharge have been lined. There are, however, still reaches where lining would be useful. The team also visited the meteorological station installed on the right flank of the dam. All instruments were working and are being

regularly observed. The timings of observations were most probably at slight variance from those being followed by IMD. The ID officers were advised to follow the timings fixed by the IMD for convenient incorporation of the data in overall network. The fisheries Dept. has introduced fish in the tank and are harvesting through cooperative societies. The Team observed a substantial area just down-stream of the dam but out of command which was said to be belonging to a number of professional doctors. A piped irrigation system has been laid out from two dug wells where water table was about a couple of meters below ground level. The offtake of water from these wells should be kept under watch as the wells are quite close to the dam. This is another example of unaccounted for project benefits which will add to productivity as well as employment leave alone other types of benefits to the owners.

Part I Works (Field Channels)

The Team visited the command area and walked along field channels in chaks 5, 9, 10, 11, 12, & 13.This was done particularly as these outlets were being run for part performance test. The field channels were well constructed. Some of these are going through filling reaches where seepage was observed. One of these reaches had a heavier seepage and the banks were saturated due to rat-holes. The lands are undulating and some lands have been shifted from one chak to another. A second look for possible readjustments would be advisable if it could obviate field channels going in filling. This region has made use of pre-cast structures on field channels.

These structures were functioning satisfactorily in normal cut and cut and fill sections but had a tendency of getting outflanked in filling reaches. Pre-cast structures have their advantages but these need to be properly embedded with protected approach and outfall channels particularly in filling reaches. As these have to be maintained by farmers, it would be desirable to have them fixed in a manner that their maintenance is economical and quick. It is

not the intention of the Team to discourage the use of pre-cast structures as they do have many other advantages, but it would at the same time like their fixing to be more sturdy. At the time of drawing water as per RWS and at the stress period of crops, the farmers will be hard pressed for time where such items can be irritating which, with some care, can be easily avoided.

Farmers Participation

There are in all 18 chaks in the command out of which 15 are on main canal and three on the two minors. The chak No. 8 of Main Canal is a lift chak. Chak areas vary from 7.95 Ha to 22.10 Ha and the number of farmers in each chak varies from 2 to 12. Outlet committees for all 18 chaks have been formed and they were involved in finalization of lay-out of field channels. The Team was informed that a Tank Level committee has also been established on this project very recently. The outlet committees have been functioning satisfactorily. The farmers have accepted the RWS system but are at present taking water only in day for 12 hours.

While the AU was quite active in advising the farmers, the ICAR also, has a research project which covers the command of this project as well. It was said to be a part of All India Soil and Land Use Survey. The senior scientist working there seemed to have developed a commendable rapport with the farmers and has done good work in advising them. There were 12 wells in command in pre-project stage but their yields were inadequate. A rise in conjunctive use was noticed and additional out of command area has also come under irrigation from wells and seepage flow available in the nalla down stream of the dam. There has been a very noticeable shift from conventional kharif rainfed cotton to soya beans and hot weather vegetables.

The farmers were very enthusiastic about high value crops and horticulture with limited water requirements. They need the Agriculture input of the AU to continue for another three years.

The computerized operation MI model was made available to the project before Rabi 90-91 and three alternate PIPs were prepared. One of them was adopted in consultation with the farmers. Further scheduling, however, could not be done through this due to a subsequent technical flaw in the soft-ware. It is a very scientific and useful aid in application of water and can improve efficiency and production considerably. It has to be allowed to function so that the ID/AD staff as also the cultivators assimilate it. The model would also require considerable fine tuning before really workable solutions are put on it. Results of this type cannot be achieved in one year and the Team recommends that necessary Technical Assistance for this should continue for another three years.

Land Acquisition

No rehabilitation was said to be involved on the project. On inquiry, the Team was informed that there were perhaps two or three cases where the farmers of submerged area were left with no land. They were reportedly given jobs by the ID on the dam & canals. The Team feels that the position be verified and employment to at least one member of such a family provided by the ID to enable them to sustain themselves.

Part Performance Test

On basis of study of back-ground material and discussions with USAID and GOM officers, the Team felt that the crux of the success of MMIP in all spheres like scientific planning, quality execution, assured supply to farm gate & etc, has been the Performance Test. Obviously, the seriousness and care with which this test was being conducted would be very vital. The Team, therefore, wanted to have a first hand feel of the same. The Nagpur region organized the test on Wakeshwar MIS. Main reason of choosing this was

availability of storage water above sill level. The Team was also conscious that kharif sowing was being done and any large scale water flows in canals and outlets could dislocate normal operations of farmers. The testing was therefore limited to releasing about 80% of the full discharge, checking flow conditions in the canal and in a group of six outlets as far down in the canal as practicable. The last permanent CTF was at 3.185 km and so six outlets upstream of that were selected. Water was gradually released in the canal at about 8.30 A.M. and the flow stabilized at about 10.30 A.M. After observing the system for about one and a half hours, the sluice was closed at 12 noon.

The canal has a designed capacity of 315.5 lps against which the discharge let out was 250 lps. After the flow was stable, it was observed that the flow was smooth and the levels were below the FSL marks on the structures. The discharge was first measured at RD 86 (CTF 1) and was 250 lps as per calibration table. The first outlet in which water was released was No.-OL-5. The canal level had fallen a little more near the outlet and it was drawing only 26 lps. The Team was told that a regulatory bed obstruction at lower discharges is required to be put here after which only O.L.-5 can draw full 30 lps. The discharges in outlets 9, 10, 11, 12, & 13 were then measured on CTFs immediately below the outlets and were found to be 30 lps. The discharge on CTF-2 at RD 3185 was 40 lps. The losses after accounting for drawals amounted to 34 lps. The readings and observations tallied with the BM IV record of the test. We walked along the field channels and found the 30 lps going down till it was diverted to natural drainages to avoid damage to sowing operations of farmers. The Team has already given its impressions about the working of field channels. These had been very well constructed and were in good condition. The reaches with heavy fillings were however not behaving including structures

put in there. The best thing would be to try to, if possible, reshuffle areas on outlets to cut out heavy filling reaches. If this is not feasible then the reaches and structures there need to be strengthened.

A copy of the report of performance test is enclosed as Annexure. The Team found that all staff, engaged on the test, knew precisely what they were required to do or observe.They knew how to conduct the test and were fully aware of its purpose and importance. They were found to be knowledgeable about what shortcomings/problems could be expected and what needed to be done about them. The Team is, therefore, convinced that the ID of GOM is going about the performance test most conscientiously. What further impressed the Team was the sense of job satisfaction that the lowest professional staff of ID exhibited. They had a sense of pride and rightly so, for having done a quality job and above all they are today in a position to ensure desired supply on each farm gate.

Observations

(1) Development of command to the tune of 83% in the very first year can be considered as a very good achievement.

(2) Proximity to Nagpur market would ultimately determine the final cropping pattern. It is felt that the AU may have to review its cropping pattern projection. With increased availability of ground water, conjunctive use is also likely to develop fast for growing high value crops. The farmers were very keen that the guidance and advice on Agriculture available to them under the project must continue till a stable pattern is established. It is recommended that this technical assistance to farmers should be continued for three years more.

(3) The computerized operation model for field application of water has not been put to use so far. It is going to be extremely useful and will result in economy of water as also in substantially increasing yields. The model will also need considerable fine tuning and the ID/AD staff as well as farmers will take sometime to get used to it. Its impact will take at least three years to be understood and then alone it will become a part of the system. It is strongly recommended that Technical Assistance on this should be continued for another three years.

(4) The heavy filling reaches of field channels be re-examined for either reshuffling of command between outlets or for required strengthening of banks as well as structures.

(5) Conjunctive use of water be encouraged.

(6) The number of farmers who were rendered landless due to submergence be verified and one person from each such family provided suitable job by ID to enable them to subsist.

(7) The farmers at present are not taking water at night and the RWS had to be revised for a canal running twelve hours a day. With the fast development of Irrigation, the canals will not be able to feed the entire area. The rotations be immediately switched over to 24 hrs. running of canals.

(8) The project has solved drinking water problem of about half a dozen villages around which is a very redeeming feature.

(9)Some wells have come up in areas which are out of command. This is an unaccounted for benefit of the project which should taken into account.

(10) Income on account of fisheries development should also be into account.

WAKESHWAR MIS

TAH - NAGPUR DIST.

- NAGPUR

PERFORMANCE TESTING OF CANAL ON DATED 6-27-91

DAM LINE	DISCHARGE IN LPS	STATION R.D. in Meter
CTF 1	250	86
OL 1		170
OL 2		410
OL 3		770
OL 4		950
OL 5	26	980
OL 6		1665
OL 7		1665
OL Lift		1715
OL 8		1830
CR		1890
OL 9	30	2275
OL 10	30	2720
OL 11	30	2845
OL 12	30	3010
OL 13	30	3140
CTF 2	40	3185
OL 14	(losses 34 lps)	3300
OL 15		3720
OL 16		4210
OL 17		4620

DATTAPUR MIS

(Visit on 6/28/91)

General

Dattapur Minor Irrigation scheme is located 125 km from Nagpur on Nagpur - Yavatmal Highway. It is 3 km. from Kalamb town and is in Amravati Region; The scheme is in Kalamb Taluka of Yavatmal Dist. The project was first sanctioned by the GOM in July 78. It was taken under MMIP in October 87 after which the works gained momentum. Since inclusion in MMIP, the project has generated 3753 man months of employment. It cleared B.M.IV in Feb.91.

Dam & Conveyance System

The dam was completed before monsoons of 1988 and has since been receiving water every year. The storage at the time of visit of the Team was partial. The dam, spillway and irrigation sluice were visited and appeared to have been very well constructed. There was a filter toe with toe drains from both flanks and V-notches for measuring seepage dishcarges.

The Team walked along the canal part of the way and drove along it for the rest of its length. The construction of the canal and its structures was of a very good quality. All structures and profiles had FSL marked on them prominently. The canal had been lined wherever necessary. The meteorological station was found to be well maintained and regular observations were being taken.

As per ASR, the project was estimated to cost Rs.10.99 million but the revised cost was indicated as Rs.11.96 million out of which Rs.11.71 million had been incurred up to May 91.

Salient Features

Reservoir Catchment Area	7.77 sq.km
Average Annual Rainfall (50% dependability)	890 mm
Yield (50% dependability)	2.1453 Mm^3
Gross Storage	1.6874 Mm^3
Dead Storage	0.0827 Mm^3
Live Storage	1.6047 Mm^3
Annual Utilization	2 . 1 4 5 1 Mm^3
Area under Submergence	39.88 Ha
Length of Dam	404 m
Maximum Height of Dam	14.88 m
Canal Length (Right side only)	5.30 km
Length of Minors (four)	3.66 km
Design Discharge at Head of canal	0.326 cumec
Number of Chaks	26
CCA	402 Ha
ICA	375 Ha
Irrigation Intensity	93%
Part I Works (Field Channels)	11

The Team visited the commanded area and walked along some of the field channels. This was, by far, the most well constructed system that the members of Evaluation Team saw during the field visits. The falls and turn outs along the field channels are particularly robust. They had been constructed in situ and are very well done. It was felt, that the willingness to take over and the subsequent success of the tank committees will depend on(1) the quality of the construction and (2) the length of the main canal

and minors compared to the area and number of farmers served by the system. Even after passing the performance test, the farmers may find it difficult to maintain systems that are not equally robust. Some sort of down the road test, performed say after two or three seasons of full operation, with subsequent modifications may be necessary if the operation of some of the systems by the farmers is to be a success. An early "rehabilitation" test may prove to be very cost effective compared to augmenting irrigated acerage from new projects.

Farmers' Participation

There are in all 26 chaks in command. The Team met a large group of farmers and officials from both the Dattapur and Rajur MIS. It became apparent quickly that there is a stronger involvement of the AD on these two projects than had been encountered so far. Not only that, there was a close working relationship between the Dept. and the personnel assigned to the projects from the PKM. The VEWs and the SMSs from both projects were in attendance. They explained that there is a sincere interest by all in the success of the project. A number of cultivators requested that the AU/AD should remain on the job.

The need for the assistance of the agriculture experts was apparent. Prior to the project, the principal crops had been a long season cotton and some chillis. Both crops were planted during the kharif season and have a growing season that extends into the rabi months. With the project, farmers are moving into double cropping with jowar in the kharif season and wheat or gram in the rabi season. There is talk of a short season variety of cotton and soyabeans in kharif followed by wheat, gram or groundnuts. Obviously the cropping pattern is still in transition from rainfed to irrigated agriculture and considerable experimenting with cropping alternatives will be taking place. Some vegetables were irrigated in the last hot season and there is much interest in this

crop. There is a clear need for assistance with the emerging cropping pattern, a need strongly expressed by the farmers.

The enthusiasm for the project was great. The chairmen of at least ten of the outlet committees were in attendance. They testified that they had been involved in the laying out of the field channels and that changes had been made to accomodate their requests. There were no reported difficulties in forming the outlet committees. In fact, tank committees have been formed for both of these projects. The chairmen of the tank committee of both were at the meeting. Both indicated that the committees were ready to take over the operation of the system, including the maintenance of the main canal.

As with all of the other MIS project visited, there was irrigated acreage made possible from wells which had more yields with the filling of the reservoir. This is acreage that represents project benefits not accounted for on the original project appraisal. Increased yield of wells was credited with solving hot season shortages of water for drinking and domestic use in some villages.

There were a number of unsolicited testimonials regarding benefits of these MIS projects. Farmers talked of now having employment, of no longer planning to sell their lands and move to town because they could not support their families. One farmer stated that he may have joined the naxalites were it not for the project. Still another compared the USAID project with another project on which he has irrigated acerage. He reported that the USAID project is better constructed. The outlet committees eliminate disputes over water. One of the farmers said that these are our irrigation works and we will look after them and see that they are not destroyed or subject to vandalism.

There were two areas that might strengthen the project. One is in the preparation of crop budgets to compare the profitability of cropping alternatives under various prices. Neither the agronomists working for the AU or the AD had
information of this type to pass on to the farmers in this project, as well all of the others which were visited. There was a belief that local markets could absorb any amount of produce grown on the projects without affecting prices. This may be somewhat optimistic.

The computorised operation MI model was made available to the project before Rabi 90-91 and PIP was finalised on that. Further scheduling, however, could not be done through this due to subsequent technical flaw in the soft ware. It is a very scientific and useful aid in application of water and can improve efficiency and production considerably. It has to be allowed to function so that the ID/AD staff as also the cultivators assimilate it. The model would also require considerable fine tuning before really workable solutions are put on it. Results of this type cannot be achieved in one year and the Team recommends that necessary Technical Assistance for this should continue for another three years.

Land Acquistion

No rehabilitation was said to be involved on the project. On inquiry, the Team was informed that there were perhaps two or three cases where the farmers of submerged area were left with no land. They were reportedly given jobs by the ID on the dam and

canals. The Team feels that the position be verified and employment to at least one member of such a family provided by the ID to enable them to sustain themselves.

Observations

(i) The ultimate cropping pattern is likely to be different compared to the one contained in the project depending upon marketability of high value crops. The availability of ground water will hasten this process by conjunctive use. It is felt that the AU may have to review the proposed cropping pattern. The farmers were very keen that the guidance and advice on modern Agriculture techniques and suitablity of various irrigated crops, available to them under the project must continue till a stable pattern is established. The Team recommends that this technical assistance to farmers should be continued for another three years.

(ii) The computorised operation model for field application of water has not been put to use so far. It is going to be extremely useful and will result in economy of water as also in substantially increasing yields. The model will also need considerable fine tuning and the ID/AD staff as well as farmers will take some time to get used to it. Its impact will take atleast three years to be understood and then alone it will become a part of the system. It is strongly recommended that Technical Assistance on this should be continued for another three years.

(iii) Conjunctive use of water should be encouraged and water table in the command kept under constant watch particularly in view of its sizeable rise.

(iv) The farmers are at present not taking water at night and the RWS had to be revised for a canal running of twelve hours a day. With the fast development of command, the canal capacity is going to run short if 24 hours irrigation culture is not inculcated. The rotations be immediately switched over 24 hours without waiting for full development as things may go out of control later.

100

(vi) The number of farmers who were rendered landless due to submergence be verified and one person from each such family provided suitable job to enable them to subsist.

(vii) The project has solved drinking water problem of some of the villages which is a very re-deeming feature.

(viii) Some wells have come up in areas which are out of command. This is an unaccounted for benefit of the project whichshould be taken into account.

(ix) Income from fisheries development should also be taken into account.

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)

Status of Studies and Diognostic Analysis (June 1991)

Status of MMIP Studies with Approval and Initial Completion Dates

Study No.	Name of the Study	Approval Date	Initial Compl.	Current Status
1	Data Collection & Processing	1/86	3/90	ongoing
2	Diagnostic Analysis	1/87	10/87	complete
3	Developement of Computer Model	1/86	3/90	ongoing
4	Setting of Sill Levels	1/86	3/87	complete
5	Sizing of Reservoirs	1/86	3/87	complete
6	Analysis of Rotational Water Supply System	1/90	-	ongoing
7	Documentation of Farmers Participation	1/86	3/87	complete
8	How to Organize Farmers	11/88	-	complete
9	Pipe Distribution System	1/87	6/87	complete
10	Baseline Surveys	1/87	12/87	ongoing

202

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)

Status of Pilot Activities
(June 1991)

Status of Pilot Activities with Approval & Initial Completion Dates

Pilot No.	Name of the Study	Approval Date	Initial Compl.	Current Status
1	Cropping Pattern Selection	9/88	6/89	ongoing
2	Developement of Groundwater	2/87	5/89	ongoing
3	Conjunctive Use of Canal and Well Water	2/87	5/89	ongoing
4	Closed Distribution System	3/89	9/90	ongoing
5	Demand Scheduling	3/89	9/90	ongoing
6	Adoptive Demonstrations	12/89	-	ongoing
7	Catchment Area Treatment	-	-	discont.
8	Womens Pilot	Ph. I 2/87	3/90	ongoing
		Ph. II 2/87	3/90	ongoing

Note: Pilots 2 and 3 and likewise Pilots 1 and 6 have been combined into a joint investigations.

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)

Status of Training Programs
(June 1991)

Status of Training Programs Conducted, In Progress, and Proposed

	Training Course	Date Appr.	Candidates Trained Proposed	Actual	Status
1.	Distribution System Planning & Layout	6/87 3/88	240	274	completed
2.	Construction Methods Part I Works	9/88	210	168	in progress
3.	Hydrometeorological Observations	3/89	210	230	completed
4.	Operation & Mainenance a) Canal Inspectors	2/90	150	-	in progress
	b) Deputy & Junior Engineers	2/90	330	219	completed
	c) Chowkidars	2/90	150	-	in progress
	d) Field Level Extension Staff & Workshop for Training of Trainers	2/90	240	165	in progress
5.	Orientation in Water Management - JE & DE	10/89	30	23	completed
6.	On-Farm Water Management - SMS	-	30	23	completed
7.	Quality Control	-	300	272	completed
8.	Farmers & MIS Staff	-	2,700	-	proposed
9.	Computer Training	9/88	480	433	on going
10.	In-Country Study Tours	9/90	64	60	on going
			5,134	1,867	

MAHARASHTRA MINOR IRRIGATION PROJECT
July 1991

Progress of Completion of Hydro-Meteorological Stations on MMIP

	Region	No. of Stations Type A	No. of Stations Type B	Stations Completed Type A	Stations Completed Type B	Total Plan.	Total Comp.
1.	Pune	7	4	7	3	11	10
2.	Konkan	4	4	1	4	8	5
3.	Aurangabad	7	6	0	0	13	0
4.	Amervati	12	8	9	8	20	17
	Total Stations	30	22	17	15	52	32

Note: Hydro-meteorological stations incorporate instrumentation for measurements of evaporation and evapotranspiration, temperature, wind velocity and direction, sunshine hours, humidity, water quality, and silt load. Ordinary and automatic rain gauges are included.

Type A Stations have arrangements for river discharge measurements with a current meter.

Type B Stations are equipped to measure discharge with floats.

ANNEXURE V-5

I.CU (USAID)
JUNE 17, 1991

MAHARASHTRA MINOR IRRIGATION PROJECT (386 0490)
STATUS OF MINOR IRRIGATION SCHEMES

SR No.	REGION	MIS No.	ICA ha	NO. OF MIS						
				ACHIEVEMENT				STATUS		
				BM I	BM II	BM III	BM IV	COMPLETE	PROBABLE COMPLETION	PROBLEM
1	AMRAVATI	11	4142	11	11	8	7	7	3	1
2	AURANGABAD	24	9361	24	24	18	8	8	13	3
3	BOMBAY	13	2165	13	13	1	0	0	4	9
4	NAGPUR	6	1484	6	6	6	5	5	1	0
5	NASHIK	16	3852	16	16	11	3	3	11	2
6	PUNE	20	5434	20	20	15	5	5	12	3
	TOTAL	90	26438	90	90	59	28	28	44	18

LCU (USAID)
JUNE 17, 1991.

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)

LIST OF MINOR IRRIGATION SCHEMES

REGION : AMRAVATI

SR NO	NAME OF MIS	ICA	PIL		DATE OF ACHIEVEMENT				STATUS/ PROBABLE COMPLETION/ PROBLEM
			No.	Date	BM I	BMII	BM III	BMIV	
	DIST : AMARAVATI								
1	GAMBHIRI	220	9	12/10/86	12/10/86	5/2/88	1/4/91	2/28/91	Complete
2	JUTPANI	175	9	12/10/86	12/10/86	11/14/87	12/11/89	1/16/91	Complete
	DIST : AKOLA								
3	MOKHEDPIMPRI	195	9	12/10/86	12/10/86	11/21/87	12/11/89	2/20/91	Complete
	DIST : BULDHANA								
4	JANUNA	156	8	3/5/86	3/5/86	2/29/88			PACD
5	WARI II	115	8	3/5/86	3/5/86	11/16/87	4/18/90		PACD
6	VYAGRANALLA	1615	8	3/5/86	3/5/86	1/29/90			PACD
7	KATAWADA	360	9	12/10/86	12/10/86	1/19/88	8/22/90	2/28/91	Complete
8	BORJAWALA	144	14	5/14/87	5/14/87	8/22/88	3/14/90	2/28/91	Complete
	DIST : YEOTMAL								
9	RAJURA	422	9	12/10/86	12/10/86	2/29/88	3/14/90	2/11/91	Complete
10	BORDA	365	14	5/14/87	5/14/87	8/31/88			Construction
11	DATTAPUR	375	14	5/14/87	5/14/87	2/29/88	1/9/90	2/11/91	Complete

201

ANNEXURE IV-7
LCU (USAID)
JUNE 17, 1991

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)
LIST OF MINOR IRRIGATION SCHMES
REGION : AURANGABAD

SR NO	NAME OF MIS	ICA	PIL		DATE OF ACHIEVEMENT				STATUS/ PROBABLE COMPLETION/ PROBLEM
			No.	Date	BM I	BM II	BM III	BM IV	
	DIST : AURANGABAD								
1	RITIMOHARDA	392	8	3/5/86	3/5/86	2/10/88	3/12/90	10/26/90	Complete
2	SOBALAON	421	8	3/5/86	3/5/86	12/15/87	3/18/91		PACD
3	PALASGAON	282	9	12/10/86	12/10/86	7/7/88	11/27/89	10/6/90	Complete
4	UNDANGAON	104	9	12/10/86	12/10/86	2/10/88	3/12/90	9/19/90	Complete
5	KUNJKHEDA	226	9	12/10/86	12/10/86	2/7/88	3/12/90	12/8/90	Complete
6	LONI	170	9	12/10/86	12/10/86	3/22/88	10/27/89	9/10/90	Complete
	DIST : BEED								
7	HIWARSHINGA	260	8	3/5/86	3/5/86	8/12/88	3/13/90	11/24/90	Complete
8	GOLANGRI	330	9	12/10/86	12/10/86	3/3/88	12/27/89	12/27/90	Complete
9	PARGAON (JOG)	113	9	12/10/86	12/10/86	2/29/88	11/18/89	6/20/90	Complete
10	MATKULI	290	9	12/10/86	12/10/86	7/10/89	1/28/91		6/91
	DIST : LATUR								
11	NAGTHANA	1578	9	12/10/86	12/10/86	6/19/89			Construction
12	YELLORI	231	9	12/10/86	12/10/86	11/18/88	2/28/91		PACD
13	MOGHA	1255	13	2/12/87	2/12/87	1/29/90			Construction
14	GANJUR	260	13	2/12/87	2/12/87	2/19/88	3/7/90		6/91
15	JANGAMWADI	190	13	2/12/87	2/12/87	9/23/88	2/28/91		6/91
16	GARSULI	489	14	5/14/87	5/14/87	4/17/89			PACD
	DIST : NANDED								
17	DHANIKWADI	460	9	12/10/86	12/10/86	9/26/88			PACD
18	MAHUR	392	9	12/10/86	12/10/86	12/8/88	7/21/90		PACD
19	PIMPALGAON(BH)	486	9	12/10/86	12/10/86	12/30/88	7/21/90		PACD
20	LOHMANDWA	277	13	2/12/87	2/12/87	11/7/88			Construction
	DIST : OSMANABAD								
21	MASLA (KD)	288	9	12/10/86	12/10/86	10/3/88	6/10/91		PACD
22	ARALICHELAM	153	9	12/10/86	12/10/86	9/5/88	9/28/90		PACD
23	POHANER	216	13	2/12/87	2/12/87	9/5/88	1/20/90		6/91
	DIST : PARBHANI								
24	GHORDHARI	498	13	2/12/87	2/12/87	11/1/88			PACD

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)
LIST OF MINOR IRRIGATION SCHMES

REGION : BOMBAY

SR NO	NAME OF MIS	ICA	PIL		DATE OF ACHIEVEMENT				STATUS PROBABLE COMPLETION/ PROBLEM
			No.	Date	BM I	BMII	BM III	BMIV	
	DIST : RAIGAD								
1	KHAIRE	136	14	5/14/87	5/14/87	2/6/88			Construction
2	PUNODE	136	13	2/12/87	2/12/87	3/10/88			Construction
3	WAWA	244	14	5/14/87	5/14/87	9/23/88			Construction
	DIST : RATNAGIRI								
4	ADARE	190	14	5/14/87	5/14/87	6/24/88			Construction
5	ASURDE	138	13	2/12/87	2/12/87	6/22/88			Construction
6	KONDIWALI	140	13	2/12/87	2/12/87	7/4/88			Construction
7	SHELDI	134	13	2/12/87	2/12/87	9/27/88			Rehabilitation
	DIST : SINDHUDURG								
8	CHORGEWADI	218	7	2/18/86	2/18/86	2/6/88			PACD
9	SANAMTEMB	170	14	5/14/87	5/14/87	2/6/88			PACD
10	TALEWADI(DIGAS)	194	13	2/12/87	2/12/87	2/5/88	3/29/91		PACD
	DIST : THANE								
11	KHARADE	176	14	5/14/87	5/14/87	6/13/88			PACD
12	UPRALE	102	13	2/12/87	2/12/87	6/13/88			Forest
13	VIDHE	187	13	2/12/87	2/12/87	6/13/88			Forest

ANNEXURE IV-9

LCU (USAID)
JUNE 17, 1991

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)
LIST OF MINOR IRRIGATION SCHEMES

REGION : NAGPUR

SR NO	NAME OF MIS	ICA	PIL		DATE OF ACHIEVEMENT				STATUS/ PROBABLE COMPLETION/ PROBLEM
			No.	Date	BM I	BMII	BM III	BMIV	
	DIST : BHANDARA								
1	SILIAMBADI	210	14	5/14/87	5/14/87	2/10/88	3/20/89	3/25/91	Complete
	DIST : CHANDRAPUR								
2	BHATALA	350	8	3/5/86	3/5/86	12/31/87	05/05/89	3/8/91	Complete
	DIST : NAGPUR								
3	TELHARA	130	9	12/10/86	12/10/86	2/29/88	8/16/89	1/22/91	Complete
4	WAKESHWAR	254	9	12/10/86	12/10/86	3/1/88	11/4/89	3/8/91	Complete
5	WADGAON	285	9	12/10/86	12/10/86	2/29/88	8/28/89	5/4/91	Complete
6	SURABARDI	255	30	9/28/88	9/28/88	3/21/89	1/21/91		6/91

MAHARASHTRA MINOR IRRIGATION PROJECT
LIST OF MINOR IRRIGATION SCHEMES

REGION : NASHIK

SR NO	NAME OF MIS	ICA	PIL		DATE OF ACHIEVEMENT				STATUS/ PROBABLE COMPLETION/ PROBLEM
			No.	Date	BM I	BMII	BM III	BMIV	
	DIST : AHMEDNAGAR								
1	THERGAON	160	9	12/10/86	12/10/86	2/1/88	3/16/91		PACD
2	KUTTARWADI	297	13	2/12/87	2/12/87	11/2/87	3/30/91		PACD
	DIST : DHULE								
3	KONDAWAL	175	7	2/18/86	2/18/86	11/2/87	6/19/89	4/2/91	Complete
4	LAMKANI	270	9	12/10/86	12/10/86	3/19/88	3/17/90		PACD
5	PADALPUR	224	9	12/10/86	12/10/86	2/2/88			Forest
6	UMRANI	105	14	5/14/87	5/14/87	4/18/88			PACD
7	RAIGAN	1120	14	5/14/87	5/14/87	12/12/88			Rehabilitation
8	SHEVALI	170	14	5/14/87	5/14/87	3/19/88	3/26/90		PACD
	DIST : JALGAON								
9	BHAGDHARA	176	9	12/10/86	12/10/86	2/4/88			PACD
10	KUNJAR-II	178	9	12/10/86	12/10/86	3/17/88	3/14/90	6/17/91	Complete
11	PIMPALKOTA(BH)	114	30	9/28/88	9/28/88	11/16/88	6/12/91		PACD
12	PIMPALGAON(WK)	114	14	5/14/87	5/14/87	3/19/88	6/15/89		PACD
	DIST : NASHIK								
13	UMRALE	152	8	3/5/86	5/5/86	3/3/88	6/22/89	1/16/91	Complete
14	DHANER	168	9	12/10/86	12/10/86	3/22/88	1/4/91		PACD
15	GAULANE	247	14	5/14/87	5/14/87	6/20/88	1/15/90		PACD
16	TALOSHI	192	14	5/14/87	5/14/87	2/28/89			PACD

ANNEXURE IV-11

LCU (USAID)
JUNE 17, 1991

MAHARASHTRA MINRO IRRIGATION PROJECT (386-0490)
LIST OF MINOR IRRIGATION SCHEMES

REGION : PUNE

SR. NO.	NAME OF MIS	ICA	PIL		DATE OF ACHIEVEMENT				STATUS/ PROBABLE COMPLETION/ PROBLEM
			NO.	DATE	BM I	BM II	BM III	BM IV	
	DIST : KOHAPUR								
1	BENIKRE	286	7	2/18/86	2/18/86	10/27/87			PACD
2	KARANJAWNE	227	39	3/17/89	3/17/89	3/6/89			Forest
3	KODE	580	13	2/12/87	2/12/87	1/6/89	3/15/90		PACD
4	KHANAPUR	131	8	3/5/86	3/5/86	10/13/88	3/12/90	1/4/91	Complete
	DIST : PUNE								
5	HADSHI	484	13	2/12/87	2/12/87	9/5/88	3/19/91		6/91
6	PARUNDE	172	7	2/18/86	2/18/86	10/5/88	3/15/90	12/3/90	Complete
	DIST : SANGLI								
7	ALSUND	165	7	2/18/86	2/18/86	3/8/88	8/11/90		6/91
8	DAFLAPUR	178	8	3/5/86	3/5/86		8/31/89		6/91
9	GHANAND	155	8	3/5/86	3/5/86	3/2/88	10/27/89	10/12/90	Complete
10	GHORPADI	196	8	3/5/86	3/5/86	3/8/88			PACD
11	PRATAPUR	212	8	3/5/86	3/5/86	3/12/88	3/18/91		PACD
	DIST : SATARA								
12	CHALKEWADI	186	30	9/28/88	9/28/88	7/14/89			Construction
13	DAMBEWADI	139	8	3/5/86	3/5/86	2/1/88	2/11/91		PACD
14	MANDVININAM	579	39	3/17/89	3/17/89	8/9/89			Construction
15	MULIKWADI	209	7	2/18/86	2/18/86	2/1/88	11/19/90		6/91
16	SANGWI(SH)	180	8	3/5/86	3/5/86	12/12/87	2/8/91		PACD
	DIST : SHOLAPUR								
17	BURIKAWATHE	232	9	12/10/86	12/10/86	3/2/88	11/7/90	3/25/91	Complete
18	DOMBARJAWALGE	120	9	12/10/86	12/10/86	12/12/87	3/16/90		PACD
19	KAZIKANBAS	555	9	12/10/86	12/10/86	7/4/88	3/25/91		PACD
20	PHONDSHIRAS	448	8	3/5/86	3/5/86	12/12/87	1/23/91		6/91

212

ANNEXURE A-1

MAHARASHTRA MINOR IRRIGATION PROJECT (386-0490)

Criteria & Conditions for Approval of Bench Marks
(June 1991)

Each individual Minor Irrigation Schemes (MIS) will be designed by the Executive Engineer of the respective regions, appraised by the Special Appraisal and Supervision Cell (SAEC) and approved by the Minor Irrigation Committee (MIC) and will be based on the criteria described hereunder.

Bench Mark I

Schemes planned by Regional circle, appraised by Special Appraisal and supervision cell, and approved by Minor Irrigation Committee and concurred to by USAID.

1. An Economic Rate of Return (ERR) of 12 percent or more, or 10 percent in tribal/drought prone areas.

2. All designs comply with the standard engineering design and cost estimation criteria established by GOM/ID and AD, and the Indian Standards Institute for various components of the scheme.

3. Estimates of monthly available water supply based on a 20 year reservoir operation study. The live storage capacity of the reservoir should be based on estimated 50 and 75 percent dependable flow as per "Manual of Minor Irrigation Works in Maharashtra State, 1983" till results of special studies and pilot projects become available.

Bench Mark II

Completion of design for irrigation and drainage system and Part I works supported by detailed layout maps of command area and soil survey reports. Village leader certification of farmers participation in determining layout of channels below the outlet and their acceptance of final plan..

1. Complete surface drainage systems is designed in the entire CCA to remove rainfall intensities of a 5-year recurrence interval rapidly enough to avoid crop damage.

2. Crop water requirements calculated according to the cropping patterns developed by AD and using the climatological data from the area or nearby area. The conveyance system capacity to be based on maximum irrigation requirements of the system.

3. The layout of the water conveyance and distribution system should be based on detailed soil and topographic surveys and finalized after reviewing the possible technical alternatives with farmers.

4. Sufficient hydraulic head to be provided to assure the designed flow between outlets and watercourses, watercourses and field channels, and a minimum of 15 cm. head between field channels and the highest point within the commanded fields.

5. Delivery system designed to be capable of delivering streams of 30 lps to gated outlets serving about 5-8 ha on a rotational basis.

6. Distribution system to be designed starting with farmer's field and moving upward through the system to the main canal outlet level.

7. Conveyance channels adequately designed and regulated with control structures to permit full delivery to each outlet even when main system is operating at 50% of design capacity.

8. Water measuring devices to be provided at the head of the main canal, at each offtaking distributary/minor and along the distribution systems required to deliver measured flows among users.

9. Conveyance system adequately protected by cross-drainage structures and escapes as needed at the end and at various points along the canal alignment.

Bench Mark III

Completion of headworks, 75% completion of irrigation and drainage system of the Command Areas, completion of Part I works in 30% of Command Area. Completion of land acquisition for distribution system duly supported by GOI reports.

1. Specified portions the conveyance channels, other delivery and drainage system measures, and Part I works completed in accordance with design criteria and conditions in items 1, 5, 7, 8 and 9 as specified for BM-II above.

2. Conveyance/distribution system to be selectively lined based on detailed soil survey data and hydraulic conductivity-seepage loss correlation.

3. A performance testing system was developed to verify adherence to the required criteria and conditions for satisfactory completion of the conveyance system.

Bench Mark IV

Completion of remaining 25% of irrigation and drainage system, remaining 70% of Part I works, resettlement of displaced land owners and establishment of outlet committees in at least half of the command area. This should be supported by GOM reports.

1. Complete surface drainage system is constructed in the entire CCA to remove rainfall intensities of a 5-year recurrence interval rapidly enough to avoid crop damage.

2. Final portions of conveyance/distribution system and Part I works are completed as specified in items 1 and 2 for BM-3 above.

3. An operations testing system was developed to verify adherence to the required criteria and conditions for satisfactory completion of the conveyance system and assuring that a flow of 30 lps could be delivered to the public outlet.

ANNEXURE B-1

Summary of Criteria and Conditions for Approval of Minor Irrigation Schemes

Each individual Minor Irrigation Schemes (MIS) will be designed by the Executive Engineer of the respective regions, appraised by the Special Appraisal and Supervision Cell (SASC) and approved by the Minor Irrigation Committee (MIC) and will be based on the criteria described hereunder:

1. An Economic Rate of Return (ERR) of 12 percent or more, or 10 percent in tribal/drought prone areas, Konkan or other areas where GOM policy provides concessions.

2. All designs comply with the standard engineering design and cost estimation criteria established by GOM/ID and AD, and the Indian Standards Institute for various components of the scheme.

3. Dam and conveyance system of each MIS constructed within four years of initiation including the distribution network (Part I works) to individual farms or to the point that serves two ha, whichever is larger.

4. Complete surface drainage system is designed and constructed in the entire CCA to remove rainfall intensities of a 5 year recurrence interval rapidly enough to avoid crop damage.

5. Crop water requirements calculated according to the cropping patterns developed by AD and using the climatological data from the area or nearby area. The conveyance system capacity to be based on maximum irrigation requirements of the system.

6. Estimates of monthly available water supply based on a 20 year reservoir operation study. The live storage capacity of the reservoir should be based on estimated 50 or 75 percent dependable flow as per "Manual of Minor Irrigation Works in Maharashtra State, 1983" till results of special studies and pilot projects become available.

7. The layout of the water conveyance and distribution system should be based on detailed soil and topographic surveys and finalized after reviewing the possible technical alternatives with farmers.

8. Sufficient hydraulic head to be provided to assure the designed flow between outlets and watercourses, watercourses and field channels, and a minimum of 15 cm. head between field channels and the highest point within the commanded fields.

9. Delivery system capable of delivering streams of 30 liters per second to gated outlets serving about 20-25 ha on a rotational basis.

10. Distribution system to be designed starting with farmer's field and moving upward through the system to the main canal outlet level.

11. Conveyance channels adequately designed and regulated with control structures to permit full delivery to each outlet even when main system is operating at 50 percent of design capacity.

12. Water measuring devices to be provided at the head of the main canal, at each offtaking distributary/minor and along the distribution system as required to delivery measured flows among users.

13. Conveyance system adequately protected by cross-drainage structures and escapes as needed at the end and at various points along the canal alignment.

14. Conveyance/distribution system to be selectively lined based on detailed soil survey data and hydraulic conductivity-seepage loss correlation.

15. Water conveyance efficiency must be supported by seepage tests on the soils that canal passes through.

16. Water is allocated according to the rotational water system as detailed in project paper.

ANNEXURE B2

CHECK LIST FOR
BENCH MARK IV

Name of MIS Taluka :

Dist

Region Circle :

Division Sub Divison :

Sr. No.	Points	Compliance
I.	**For the entire Irrigation and drainage system and specifically the remaining 25 percent Irrigation and Drainage System. :**	
i)	Whether bed stones are fixed. :	
ii)	Whether profiles are constructed. :	
iii)	Whether measuring devices are constructed on distributaries and Minors. :	
iv)	Whether the grooves showing the minimum operatable water level and full supply level are marked on canal structures. :	
v)	Whether dot chart for canal structures is enclosed :	
vi)	Whether operation plan prepared and management staff briefed and participated in operation testing :	

Sr. No.	Point	Points	Compliance
	vii)	Whether operation test for entire water carrier system is carriedout and results enclosed. :	
	viii)	Whether the command plan showing entire command area and specifically the remaining 25% Irrigation and Drainage work completed is enclosed :	
II.		**Entire Part-I works and specifically remaining 70%.**	
	i)	Whether command plan showing entire Part-I work completed is enclosed. :	
	ii)	Whether full supply level corresponding to 30 liters/sec. discharge is marked on first structure, immediately below the outlet. :	
	iii)	Whether operation test is carried out for entire part-I works and results enclosed. :	
III.		**Rehabilitation and Land Acquisition.**	
	i)	Number of displaced land owners :	
	ii)	Whether their resettlement is done :	
	iii)	Whether JMS statement alongwith JMS map showing acquired land is attached. : Yes (Consult G.R.of 1972 modify accordingly upto Section VI).	

Sr. No.	Points	Compliance
IV.	**Outlet Committees (OC)**	
i)	How many chaks are in command area.	: 21 Chaks
ii)	How many OC are organised and took possession of Part-I works.	: 21chaks
iii)	Percent of total CA covered by OC.	: 100%

EXECUTIVE ENGINEER,
MINOR IRRIGATION DIVISION
SANGLI.

221

ANNEXURE C-1

Stages of Completion for Release of Fixed Amount Payable for Construction of an approved Minor Irrigation Scheme

S.No.	Benchmarks	Percentage of A.I.D. Contribution (67%) to be Disbursed
1.	Schemes planned by Regional circle, appraised by Special Appraisal and supervision cell and approved by Minor Irrigation Committee and concurred to by A.I.D.	15
2.	Completion of design for irrigation and drainage system and part I works supported by detailed layout maps of command area and soil survey reports. Village leader certification of farmers participation in determining layout of channels below the outlet and their acceptance of final plan.	15
3.	Completion of headworks, 75 percent completion of irrigation and drainage system of the Command Areas, completion of part I works in 30 percent of Command Area, Completion of land acquisition for distribution system duly supported by GOM reports.	45
4.	Completion of remaining 25 percent of irrigation and drainage system, remaining 70% of Part I Works, resettlement of displaced land owners and establishment of outlet committees in at least half of the command area. This should be supported by GOM reports.	25

Releases under 3, and 4 subject to A.I.D. verification of physical completion, including inspection which may be on a sample basis.

-222-

(DRAFT)

Adoption of performance and operational testing procedures on Minor Irrigation Schemes -

GOVERNMENT OF MAHARASHTRA
Irrigation Department,
Tech.Circular No.Misc.1090/313/9 (2)
dated the ...May, 1991.

1. PREAMBLE :

Maharashtra Minor Irrigation Project has been undertaken by the Irrigation Department of Government of Maharashtra with the assistance from USAID. Reimbursement under this project has been decided on completion of Bench Marks i.e. stages specified in the project as under :

(1) Scheme planned and approved by Minor Irrigation Committee.

(2) Design completed for distribution system and Part I works Farmers participate in determining layout of channels below the outlet.

(3) Completion of headwork, 75 percent completion of irrigation and drainage system of the command area, 30 percent completion of Part I works of the command area, completion of land acquisition for distribution system.

(4) Completion of remaining 25 percent of irrigation and drainage system, remaining 70 percent of Part I works, resettlement of displaced land owners and organization of outlet committees in at least half of command area.

In view of large extent of the project area and number of large and small channels and structures involved, it is very difficult to check physically correctness of the constructed system. Verification of dimensions of system does not define the quality of the system necessary for the Hydraulics. Entire system is planned, designed and constructed to confirm water supply at each farm gate. There is no verifiable indicator for this ultimate goal in the present monitoring system.

This situation demands introduction of a testing procedure for assurance of completion of system as designed within the permissible limits. As the ultimate aim of the distribution system is to supply water at each farm gate (with flow of 30 lps at outlet in MMIP), hydraulic testing of the system is the only way out. Performance Test and Operation Test are step by step activities planned in the distribution system of a MIS to verify performance of the system.

2. PERFORMANCE TEST :

(1) NECESSITY :

During Diagnostic analysis of twelve existing systems in the MMIP, main shortfall is insufficient discharging capacity due to heavy seepage in

canal reaches, and leakages in structures and junctions. At present, after physical completion of work to the dimensions, it is declared to be complete only on the basis of check of measurements. This however, does not assure operational performance of system at the peak flow and may not limit transit losses to design assumptions. This is the essential feature of the system for full irrigation development. At present this aspect is not verified prior to commencement of irrigation in the newly constructed system. Farmers aware of the shortfalls do not demand irrigation water. ID operating field staff is as well not aware of condition of system. This results in deficient distribution system deteriorating fast.

(2) TEST :

Performance test is the hydro-dynamic test of the system at the construction stage. It assists to pin point deficiencies in hydraulic performance. This test is useful to check performance of part or whole of the system of main canal, distributaries, minors and field channels. It is a direct tool for the construction Engineers to assess the quality of construction of the system as compared to the designed.

The Performance test confirms behavior of system on following points :

a) Peak discharging Capacity of canal compared to designed.
b) Weak reaches and locations in canal system.
c) Designed FSD Vs actual FSD
d) Functioning of measuring devices
e) Relation between FSD and discharge of canal
f) Identification of Canal reaches in pervious strata & extent of leakages.

Step - by - step procedure for carrying out the performance test is given in Annexure I.

3. OPERATION TEST :

(1) NECESSITY :

In the operation of canal system, demand of water is variable. Though the system is checked for performance test at peak discharge, its efficiency drops down considerably when operated at low discharge. It cannot function below a particular level of demand. Operation of outlets can not be altered freely as per requirements. Its range of operation is rigid and not known in advance. With the introduction of new crops and varieties, irrigation water demand will be changing year to year. It is therefore essential to understand operational flexibility of the system in advance.

Involvement of WUAs in decision of crop selection, rotation and scheduling is the policy of GOM ID in MMIP. For a purposeful dialogue and assistance to WUA in decision making, the engineer should know well the operational flexibility of the system. Operation test is a tool to acquire this information.

(2) TEST :

The operation test is designed to ensure and understand operational flexibility of the system for varying conditions of operation before hand. It highlights following features of the system :

a) Canal releases and variation in operation of sets of outlets to provide desired discharge at outlet heads.
b) Canal losses compared to designed one and its variation with respect to flow in the channel.
c) Feasible operational sequence of outlets, use of control structures and matching canal operation.
d) Losses in distribution system down to farmmgate, and relation to length for varied flow in channel.
e) Travel time for different flow conditions.

Step - by - step procedure for carrying out the operation test is given in Annexure II.

Performance tests and operation tests are carried out on about 60 MIS and 25 MIS successfully by March 1991 under Maharashtra Minor Irrigation Project. These tests are found helpful for checking construction quality of the distribution system and satisfactory operation while handing over the scheme to Management Division.

4. After taking into consideration the experience of these tests on schemes under Maharashtra Minor Irrigation Project, Government has now resolved that the performance and operation test may be carried out for all the Minor Irrigation Schemes before handing over to Management Division.

5. These tests should be carried out jointly by officers from Construction and Maintenance divisions not lower than a junior Engineer. Chak committees should be involved during tests of field channels. The test report with the observations should be jointly prepared and signed as a token of acceptance. This report should form a part of documents for transferring a scheme.

By order and in the name of Governor of Maharashtra.

(V.N.CHANDRATREYA)
Deputy Secy. to Govt. of Maharashtra

Encl. : As above

225

STEP-BY-STEP ACTIVITIES IN PERFORMANCE TEST

1. DESIGN PROCESS OF DISTRIBUTION SYSTEM :

While designing the distribution network, peak water requirements through the system is estimated with the predicted crop mix and water requirement during crop period. Water requirement is to be catered in a fixed duration i.e. rotation period for the entire command area. Canal system should have adequate capacity to meet the demand at the peak requirement within this rotation period. This aspect is examined with the help of operation program of the outlets. With the operation program maximum outlets which are to be opened is decided. This exercise is done at the time of project preparation stage. Peak flow required in the canal thus estimated works as the base for designing the canal sections in different reaches. Water allowance of the system is estimated at this stage. Construction of the canal system is executed as per this design with estimated conveyance losses included therein.

2. PERFORMANCE TEST :

Performance test is hydro-dynamic test of the system at construction stage. This test is useful to check performance of part or whole of the system of main canal, distributaries, minors and field channels. It assists to pin point, hydraulic performance deficiencies. It is a tool for the construction Engineers to assess quality of construction of the system to the designed requirements. Test is based on " Inflow - Outflow " test used for estimating Conveyance losses.

Performance Test is an event while the construction work is in progress. It includes -

(1) Planning the test,
(2) Trial run,
(3) Field test observations,
(4) Data analysis.

Objects of the test are :

a) Canal network constructed conforms design parameters,
b) Travel time up-to tail is confirmed,
c) Some Part I works are tested.

Step-by-step procedure for these activities are given below :

3. PREPARATION OF TEST PLAN :

(1) Observation Stations and infrastructure :

i) **Schematic Diagram** : Prepare a schematic diagram of the channel system demarcating the portion proposed to be tested. This will include main canal, distributaries, minors, sub-minors and field channels.

ii) **Observation Stations** : Mark locations of observation points. Observation stations will be structures as outlets, cross-regulators or head regulators, syphons, measuring devices. Number them serially.

If there are off-taking channels to main canal, numbering may be in continuing order including off-taking channels to avoid duplication of numbering.

At every observation station, defined section of canal is necessary. A profile wall if available close - by, can be the location of the observation station.

A profile wall near vulnerable portion of deep cutting, heavy banking, where seepage is to be observed can be selected as additional observation station.

iii) **Escape** : Normally every channel is provided with a tail escape. If there is no escape available down stream of system under test, a temporary escape is necessary to dispose the flow released during the test safely.

(2) Instruments :

i) **Measuring Devices** : Cut - Throat Flumes are commonly used for measuring the flow. V- Notches at specific locations can be used for measuring flow.After the discharge observation stations are decided. Considering CTFs already available in situ, additional requirement for temporary fixing at stations are to be estimated. For field channels, a pair of portable 30 lps CTF is sufficient.
One meter long steel / wooden scales, one at each station are required for measuring water depth in the canal.

ii) **Watches** : The observer at each station should have a watch (preferably wrist) & timing of all watches set to a common watch.

iii) **Blank observation sheets** : Copies of blank forms for recording the observations are to be prepared in sufficient number. Total number of such forms are to be estimated based on number of observation stations and readings to be recorded at each station.

iv) **Miscellaneous** : Cutting axes, shovels, pickaxes, ghamelas, and other such excavating tools, empty gunny bags shall be required to face any situation of canal overtopping. Small quantity of sand, metal, rubber packing, cement, on site is necessary to meet the situation

(3) Manpower :

i) **Observers** : One Observer will be necessary for each observation station. Observations at every station will be continuous. Two or three observers are to be in reserve.

ii) **Supervisor** : One senior Engineer with vehicle shall be moving on the system and supervise the test proceeding. Two messengers with vehicles may assist him on site. Closing and opening of gates is to be watched by him.

iii) **Supplementary Manpower** : This Test planning be kept in mind & tried during trial run. Trial run & Performance test require staff for full day. It is, always necessary to arrange for their food and drinking water at site.

In view of continuous hard work during the day, selection of healthy and alert observers is necessary from the field staff.

4. TRIAL RUN :

Trial run is the preparatory step towards performance testing by exposing the constructed system for hydraulic operations. In the distribution system spread over a large area and consisting number of structures and cutting and embankment it is desirable to open out the system slowly to the hydraulic force. It is likely that small defects in the system, with release of water may get enlarged damaging the system on a large scale. **Trial run infuses confidence in the field officers about the capability of the performance of the system.**

a) It is desirable to begin trial run early in the morning.

b) All the participants be allotted certain reaches of the system for observation. All of them should be at head of the allocated reach before water is let out in the canal.

c) Water be released through the head regulator and flow increased slowly. In any case the flow should not exceed the maximum capacity. Discharge in canal initially may be 50% of designed discharge till the flow gets stabilized.

e) A moving observer group shall move from head to tail and watch the functioning of the system and approve to increase the flow from HR.

f) After the flow is stabilized, the observer group will move from HR down to the last point of the system and note the locations of leakages, scouring and silting, encroachment on free board. This note of observations will include defects observed and recommendations to rectify them.

All the defects are to be rectified and removed before the Performance Test is planned.

5. FIELD OBSERVATIONS OF TEST:

(1) Canal system down to outlet :

a) Allocate each observation station to an observer. Explain the procedure of recording the observations. Observations of depth of water with reference to the reference point at the station are to be recorded at an interval of every 15 minutes. In case of flow recording stations observe all gauges. This has particular reference to CTF where both Ha & Hb are to be recorded. Set the watches to standard time. All the observers should be at their stations with their registers and instruments at least 15-20 min. before the water is released in the canal.

b) The supervisor should ensure the above preparation before commencing the test by visiting the stations from Tail portion to HR.

c) Let out water in canal to the predecided flow rate. supervisor shall move with water along the canal side and watch the system.

d) All cross regulation shall be checked frequently.

e) Open the planned distributaries, minors and outlets before the water reaches that location.

f) Observer should watch that flow becomes steady.

g) Note down reaches of disturbance seen or likely to be.

h) Note down losses through outlets, CD works, pipes, bank-works, unauthorized cuts formed due to cattle crossings or road crossing.

i) Confirm outlets, aqueducts, syphons, road crossing are not leaking. If leakages are seen, arrange flow measurement by installing portable CTF/V-Notch.

j) Observer unit will continue to move throughout the test period and be watchful of proceeding the test.

k) Recording should be continued till the last observation station records steady flow conditions for at least two hours.

k) All outlets are closed, tail escape be kept open.

l) HR gate to be closed gradually. Observations to be continued till water seizes to flow at the station.

(2) Field channel system down to farm gate :

This test apprises delivery capacity at the farthest turn out.

i) In case there is no provision of a measuring device below the outlet, make the permanent mark on any structure or lined portion of FC just down of outlet for a flow of 30 lps (or any decided flow

rate) measured with the help of portable CTF. Fix the portable CTF near the longest TO of the FC. In case there is a free fall available near the last TO, V-notch can also be fixed for measuring the flow.

ii) Release water by opening outlet to the designed flow rate (30 lps).

iii) Measure discharge & travel time at tail TO with the help of measuring device after the flow is stabilized.

Format for recording observations is enclosed.

6. COMPILATION OF OBSERVATION DATA & ANALYSIS :

All observations are to be converted to a base time and water levels to common Bench Mark. For the flow observations water depths observed at the measuring devices are to be converted to flow measurements. Care should be taken to determine the flow conditions - Free or Submerged flow in case of flumes. These converted observations are to be compiled in one statement. It can be separate for each of canal system and also field channels. These observations should be selected for steady flow condition and analyzed further to estimate seepage losses, travel time, hydraulic gradient. Presentation of these results graphically helps comparison of the observations with design assumptions. Following are few graphs suggested for the analysis of observation data.

1) Travel time as per design & as per observations shall be plotted against length of channel. Slope of line will indicate flow characteristics of channel.

2) Discharge measured at various locations and canal length indicates losses in travel length.

3) Water level & time when plotted indicates the travel time, hydraulic gradient and seepage losses simultaneously.

4) Water level and length of canal indicates the actual hydraulic gradient of the flow. This indicates probable reaches of higher seepage compared to designed.

7. CONCLUSION OF THE TEST :

From the above analysis following conclusions can be drawn :

1. To what extent constructed channels are capable to carry designed discharges.
2. Pervious reaches of channel,
3. Whether any section of channel requires improvement for maintaining required water depth at outlet or branching canal.
4. Actual FSL compared to designed FSL in channels.

A report describing area of system for test, diagram of observation stations, statements and graphs is a helpful document for the construction and operation engineers.

ANNEXURE C-4

STEP-BY-STEP ACTIVITIES IN OPERATION TEST

1. NECESSITY :

While operating the canal system, to meet water demand of all benefitted zone, within stipulated period (rotation period), program of water releases to different chaks is planned in advance. This is the Rotation Water Schedule (RWS). The flow period in the schedule is variable with reference to the stage of crops, soil characteristics and climatic conditions. The canal releases depend upon number of outlets opened on a particular day and transit losses in the system. Water release program is modified daily with the canal flow varying from peak designed to a part of it. This variation of flow affects the distribution efficiency . Its efficiency drops down considerably when operated at low discharge. At times it cannot function below a particular level of demand. Thus operation of outlets can not be changed freely to any extent. Though the system works satisfactorily for peak flow in " Performance Test ", its range of operation is not known in advance at present. With the introduction of new crops and varieties, irrigation water demand will be changing year to year.

Involvement of WUAs in decision of crop selection, rotation and scheduling is the policy of GOM ID in MMIP. For a useful dialogue and assistance to WUA in decision making, the engineer should know operational flexibility of the system.

2. OPERATION TEST :

The operation test is designed to ensure and understand operational flexibility of the system for varying conditions of operation beforehand.

Purpose of the operation test are :

a) To decide canal releases for varying operation of outlets to divert desired discharge at outlet heads.

b) To estimate actual canal losses and its relation with varied flow in the channel.

c) To understand feasible operational sequence of outlets, use of control structures and matching canal operation.

d) Travel time for different flow conditions.

3. PREPARATION OF TEST PLAN :

(1) Observation Stations and infrastructure :

i) **Schematic Diagram** : Prepare a schematic diagram of channel network for the entire system.

ii) **Observation Stations** : Mark locations of observation points. Observation stations will be all outlets, cross-regulators, head regulators and measuring devices. Number them serially.

If there are off-taking channels from main canal, numbering may be in continuous order including off-taking channels to avoid duplication of numbering.

At every observation station, defined section of canal is necessary. A profile wall if available close by can be the location of the observation station.

iii) **Escape** : Normally every channel is provided with a tail escape. If there is no escape available down stream of system under test, an escape is to be provided.

(2) Instruments :

i) **Measuring Devices** : Cut Throat Flumes are commonly used for measuring the flow. V - Notches at specific locations can be used for measuring flow. For field channels, a pair of portable 30 lps CTF is required.

One meter long steel / wooden scales, one at each station are required for measuring water depth in the canal.

ii) **Watches** : The observers should have a watch (preferably wrist) & timing of all watches set to a common watch.

iii) **Blank observation sheets** : Copies of blank forms for recording the observations are to be prepared in sufficient number. Total number of such forms are to be estimated based on number of observation stations and readings to be recorded at each station.

iv) **Miscellaneous** : Sundry tools such as cutting axes, shovels, pickaxes, ghamelas, other excavating tools, empty gunny bags, small quantity of sand, metal, rubber packing, cement, on site is helpful to face the situation of canal overtopping, leakages of structures.

(3) Manpower :

i) **Observers** : Number of observers depends upon the nature of test i.e. at one time or through the season. Four to five observers are sufficient for this test.

ii) **Supervisor** : One Senior Engineer with vehicle shall be moving on the system and supervise the test proceeding.

In view of continuous and important data collection, selection of knowledgeable and alert observers is necessary.

4. IN - SEASON TEST :

Many times, minor irrigation schemes when completed just before the irrigation season, a situation is created when there is demand of water for irrigation use and the water to be released for test can conveniently be used for irrigation purpose. In such case the all test conditions can not be created in one day. In such a case, the irrigation operation can be continued for the entire season as planned, with the releases from HR adjusted to match the opening of outlets as proposed in the operation plan of outlets. The discharge/gauge observations at all the stations in the stable flow condition are to be noted. With the opening and closing of outlets/minors/sub-minors, conditions of operation will vary. Observations of each such condition are to be recorded. The operation data can be collected during irrigation operation throughout the season. During the process of irrigation, different situations occur in the system. All the data collected during the entire season can be sieved for different situations of operation and compiled to analyze for estimating the conveyance efficiencies for different conditions occurred. In this case, the supervisory field staff is required to be attentive while recording data throughout the season of irrigation. This method has a unique advantage that no water is to be reserved specially for the testing. Additionally, different situations may occur in the operation than the planned test and data collected is for real situation in operation. This also needs preplanning of data collection program in the entire season.

5. ONE TIME TEST :

Where the system is physically complete and irrigation season is yet to commence with or is midway, and the system is to be handed over to operation staff, the operation of the system can be tested with a preplanned testing process.

6. STEP-BY-STEP ACTIVITIES FOR FIELD OBSERVATIONS :

(1) Canal system down to outlet :

a) Prepare a daily program for recording observations for testing of entire system.

b) Allocate each observation station to an observer. Explain the procedure of recording the observations. Observations of depth of water with regard to the reference point at the station are to recorded at an interval of every 15 minutes. In case of flow recording stations observe all gauges. This has particular reference to CTF where both Ha & Hb are to be recorded. Set the watches to standard time. All the observers should be at their stations with their registers and instruments at least 15-20 min. before the water is released in the canal.

c) The supervisor should ensure the above preparation for commencing the test by visiting the stations from tail portion and reach to HR.

d) Let out water in canal to the predecided flow rate. Supervisor shall move with water along the canal side and watch the system.

e) All cross regulation shall be checked frequently.

f) Open planned distributaries/minors/outlets before water reaches there.

g) Supervisor should watch that flow becomes steady. As soon the steady flow observations are recorded for one situation, he should communicate the opening and closing of outlets as planned to create condition of second situation and ascertain that the observations are recorded at all stations for each situation.

h) Repeat the process for all the planned situations.

i) Note down locations of outlets where the designed discharge could not be diverted through the outlet. Construct a temporary blockade to divert the desired flow in the outlet. Record the height of the obstruction in such case. In case there is short fall in the flow rate in a outlet/s, measure the actual discharge with the help of a portable CTF. In case it is possible to increase the HR release to meet the shortfall, canal flow can be adjusted and recorded.

j) Confirm outlets, aqueducts, syphons, road crossing are not leaking.

k) Observer unit will continue to move throughout the test period watchful of proceeding the test.

l) Recording should be continued till the last observation station records steady flow conditions for the last situation.

m) HR gate to be closed gradually.

(2) Field channel system down to farm gate :

This test apprises capacity to deliver water at the longest turn out of each branch of FC network.

i) Find out whether there is a measuring device below the outlet or a permanent mark on any structure or lined portion of FC just down of outlet for a flow of 30 lps (or any decided flow rate). Fix the portable CTF near the longest TO of the FC. In case there is a free fall available near the last TO, V-notch can also be fixed for measuring the flow.

ii) Release water by opening outlet to the designed flow rate (30 lps).

iii) Measure discharge & travel time at tail TO with the help of measuring device after the flow is stabilized.

iv) In case there are branches in the FC network, repeat the process for each of the branch separately.
Formats for recording observations are enclosed.

7. COMPILATION OF OBSERVATION DATA & ANALYSIS :

Data so collected in both the above cases are to be properly compiled for different situations of operation and tabulated. Statistical analysis and graphical representation of the data indicates the behavior and flexibility of operation of the system. Graphical presentation for analyzing the observation data are given below. In particular cases suitable additional graphs may also be helpful.

i) Main Canal and distribution losses compared to flow in the canal for different flow conditions with reference to flow rate and distance.

ii) Travel time for different flow conditions.

8. CONCLUSION OF THE TEST :

From the above analysis following conclusions can be drawn :

1 Required canal releases for operation of different sets of outlets,
2 Canal losses compared to designed and its variation with flow in the channel.
3 Feasible operational sequence of outlets, use of control structures and matching canal operation.
4 Losses in distribution system and relation to length for varied flow in channel.
5 Travel time for different flow conditions.
6 Small permanent bunds for diverting designed flow in the outlet for lowest discharge in the parent channel.

A report describing area of system for test, diagram of observation stations, graphs, statements and graphs is a helpful document for the operation of RWS system.

ANNEXURE G-1

PARTIAL
LISTING OF AVAILABLE SOFTWARE GOM/ID

Sl.No.	SOFTWARE	LANGUAGE OR SOFTWARE USED
1.	Compiling, storing, Reporting and analyzing Rainfall, Discharge, Sediment Climatological and Water quality data being collected.	Dbase, Clipper and R & R
2.	Annual rainfall depend ability, fort-nightly rain fall distribution	Lotus 123
3.	Calculates Rainfall Runoff co-relation and gives yields for various dependability along with requisite graphs.	Lotus 123
4.	Calculates WAR and various summaries viz, monthly, fort nightly, yearly etc.of daily rainfall, Runoff, Hydromet-data	Dbase IV
5.	Calculates Area table for River gauging site for a given river cross section for each compartment at the interval of 1 cm. of reduced level	Quick basic
6.	Computation of Earthwork for given canal alignment including quantity of cutting (strata wise), banking (hearting Casing) success years for a given inflow series for a dam site for various carry overs.	Lotus 123
8.	Prints Biodata of officers using data Dbase from Dbase files	Dbase III + & Relational Report Writer
9.	Computers inflow, utilization for given daily tank data	Dbase III + & Relational Report Writer

Sl.No.	SOFTWARE	LANGUAGE OR SOFTWARE USED
10.	Canal design for given discharge as per GOM norms.	Lotus 123
11.	Sediment analysis by New Zero elevation method	Lotus 123
12.	Net irrigation required	Lotus 123
13.	Slip Circle Analysis	Lotus
14.	Data Base Management for Flood forecasting	Clipper
15.	Design of hydraulic jump type stilling basin	QBasic
16.	Rainfall and Runoff estimations	DBase
17.	Paybill and pay slips in Marathi	Lotus
18.	Conversion of Figures into words	Lotus
19.	Micro power Generation Feasibility	QBasic
20.	G.P.F. Account and slip	Lotus
21.	Seniority list of : (i) Tracers (ii) First Clerk (iii) Technical Assistants (iv) Superintendent (v) Senior Clerk (vi) H.G. Steno (vii) Lower Grade Steno (viii) Divisional Store Keeper (ix) Head draftsman (x) Draftsman (xi) Assistant Draftsman (xii) Assistant store keeper (xiii) Steno typist	DBase
22.	Estimates and design of Kolhapur type Bandhara	Lotus/analyzed estimates
23.	Calculation of high flood level in nalla/river	DBase

Sl.No.	SOFTWARE	LANGUAGE OR SOFTWARE USED
24.	Bimonthly reports	Lotus/DBase
25.	Reservoir operation table for individual reservoir and for integrated reservoirs	Lotus
26.	Water bill in Deonagri script for part area of one project	DBase
27.	Rate Analysis for selected items	Lotus
28.	Daily water level, storage in dams entry and its trans mission to Pune through NIC-NET network.	DataLotus
29.	Computation of Gradually Varied Flow by standard step method	Lotus
30.	Processing of rainfall data for K.T.weir yield study	DBase
31.	Simulation studies for Reservoirs	
32.	Simulation studies for Reservoirs for inflow as variable	
33.	Design of canal section	
34.	Water Account of Penganga Basin	
35.	Calculation of Crop Water Requirement for crops using modified Penman method and simulation studies of reservoirs for a long series	
36.	Net Agriculture Benefits for Irrigated and unirrigated crops	
37.	B.C. Ratio calculations	
38.	Earthwork calculations for Earth Dam (excluding pitching, & filter material)	

238

Sl.No.	SOFTWARE	LANGUAGE OR SOFTWARE USED
39.	Hydraulic Design of Aqueducts	
40.	Stability Calculation of Abutments for aqueducts	
41.	Stability of Transition walls for aqueducts	
42.	G.P.F. Account of Class IV Employees	
43.	Fixing Box size of Aqueduct	
44.	Hy. Design of Unlined Channel	
45.	Analysis of Weather Data	Parameters
46.	Reference ETO Calculations	
47.	Rotational Water Supply Schedule Below the outlet	
48.	Rotation Schedule of Minor By Grouping of Outlets	
49.	Dependable Rainfall Runoff	
50.	Computation of Back Water Profile	
51.	Hydraulic Design of Unlined Canal	
52.	Determination of Depth of Flow In Open Channel	

ANNEXUREJ-1

Observations by Shri Shinde, Executive Engineer, Special Analysis and Evaluation Cell, and Shri V.N. Wagh, Deputy Engineer, Minor Irrigation Cell during the 'Performance Testing of the Benikre M.I. Scheme' on 18.5.1991-----

1. As per requirement of B.M. III, full length of the Right Bank Canal and part length, viz. 3.375 Km of the Left Bank Canal are required to be completed for carrying on Performance Testing.

2. The performance of the Right Bank Canal has already been tested during the last Rabi Irrigation Season.

3. The Left Bank Canal is now tested for its performance. For this purpose the Left Bank Canal is required to be opened at Head with peak requirement of 269 lps. The C.T.F. (size 40 x 180) at Head was showing the Ha = 0.45 which would give discharge of 271 lps, under 'Free flow conditions'. However the discharge flowing through the CTF was under submerged conditions. As such the discharge passing through the CTF was 226 lps and not the desired discharge of 269 lps. It was reported by the field Deputy Engineer that the 'CTF' is properly installed by considering the required 'Delta'. Thus the submerged condition might have been created due to 'humps' in the canal bed. On the downstream side of the CTF the CBL on the downstream may be verfied and brought to the designed gradient.

4. Leakages to the extent of approx. 1 to 3 litres were observed at 11 the outlet gates. Those may be stopped.

5. The LBC crosses a number of natural drainage courses where the CBLs are below the bed levels of these courses. In such cases the flow of natural drainage course is allowed in the canal.

However this is not desired. Since it may cause silting in the canal section and consequently affect the performance of the canal system. This may please be reviewed and it may be observed that all nalla flow shall be diverted to nearest nalla through catch water drain or separate super passage structure may be provided after due consideration and verification.

6. Heading up of water was observed at O.L.2, O.L.6, O.L.9, O.L.11. This may be due to 'humps' in the canal bed on downstream of these outlets or insufficient c/s of the canal. This may be verified by taking 'bed levels' and widths of excavated canal section at close interval say 5m.

7. Heavy leakage was observed at the junctions of the H.P. acqueduct at Ch 2645. No sufficient waterway is provided for nalla flow.

8. Two H.P. culverts viz @Ch.1410 and Ch2520 are yet to be constructed. Similarly the offtake structure for minor 1 is yet to be constructed.

9. The travel time observed for the 3.375 Km (CTF location) was 4 hrs. The discharge measured at CTF Ch3375 was only 56 lps. The transit losses thus work out to be 170 lps as against the designed losses as 34 lps. In order to reduce the transit losses the leakages may be stoppe by carrying out necessary rectification and the seepage may be minimised by providing remedial measures such as 'selective lining' after identifying the seepage pockets.

10. The designed "F.S.L., R.L." and "Minimum driving Head" is required to be marked at each outlet structure. Similarly a 'groove' showing water level for 30 lps may also be marked on the first structure in the F.C.

ANNEXURE VII

REFERENCES CITED

Maharashtra Minor Irrigation Project

(Final Evalution - July, 1991)

1. Amravati Irrigation Department - Office of the Chief Engineer, "Sample Output Results of Computer Programs at Amravati Computer Center", GOM,1991 MIMEO

2. Computer Assisted Development, Inc., "MI Model Version 1.1 User's Manual Supplement, ISPAN". Maharashtra Minor Irrigation Project, May 1991

3. Computer Assisted Development Inc. "Minor Irrigation Model - Users Manual", Fort Collin, Colorado, USA, September 1990

4. Computer Assisted Development, Inc., "Conjuctive Use Assessment for MMIP", USAID/MMIP (386-0481) February 1987 Pune, India

5. Computer Assisted Development, Inc., "Conjuctive Use Assessment for MMIP", USAID/MMIP (386-0490) September 1990 Pune, India

6. Directorate of Irrigation Research and Development, Pune,MMIP "VISIT OF EVALUATION TEAM NOTES GOM", Superintending Engineer, 18 June,1991, Pune, India, MIMEO

7. Dimble, R.S. and Deshpande, V.S., "Development of Communication Skills, 'Role Plays'",USAID/MMI Project, Prabodh Sampada,Pune, India, 1990

8. Department of State, Agency for International Development, "Project Paper", India. Maharashtra Minor Irrigation (386-0490) USAID/India, May 1984

9. Directorate of Irrigation Research & Development, "Seepage Loss Study", USAID/MITM (386-0481) July 1988, Pune, India

10. GERARDS, LMH, "Special Studies in Irrigated Agriculture, Portfolio of USAID/India", USAID June 1987, New Delhi, India

11. Gokhale Institute of Politics & Economics, "Utilization of Kharif Irrigation Potential", USAID/MITM (386-0481) February 1987, Pune, India.

12. Govt. of Maharashtra, Chief Engineer, Irrigation Department, "Bench Mark Reports - I, II, III, and IV" for; Parunde, Singli MIS, Pune Region; Hiwaesinga, Undangaon, Loni MIS, Aurangabad Region; Telhara, Wakeshwar, Wadegaon MIS, Nagpur Region; and Katwada, Dattapur MIS, Amravati Region of the Minor Irrigation Divisions thereof.

13. Government of Maharashtra, Pune Irrigation Circle, Pune, "Report Operation of Parunde MIS, Rabi (winter) 1990-91", Pune PID, 1991

14. Government of Maharashtra, Irrigation Department. USAID/MMI (386-0490) "Analysis of the On-going Studies of How Best to Organize Farmers For Operation and Maintenance of Minor Irrigation Systems", Special Study No.8, Direcotrate of Agriculture, Pune, Oct., 1990

15. Government of Maharashtra, Irrigation Department, USAID/MMI (386-0490), "A Note on Microcomputer Training Activity Under MMIP", Superintending Engineer and Director, Irrigation Research and Development, June, 1991, Pune, India

16. Govt. of Maharashtra Irrig. Dept., "Setting of Sill Levels of Reservoirs", USAID/MMIP Special Study No.4, SAEC, Pune, March 1988.

17. Govt. of Maharashtra, Special Analysis and Evaluation Cell, Pune, "Brief Note for Visit of Evaluation Teams", June 1991

18. Irrigation Department, Amravati Region. "Lessons Learned from the USAID M.I. Projects and its applications on Non-USAID M.I. Projects", Amravati, June 1991

19. Liaison and Co-ordination Unit, USAID/MMI Program (386-0490) "Activities of Agricultural Discipline, Parunde MIS" - (Pune Dist).

20. Liaison and Coordination Unit USAID/MMI Project, "Evaluation Report, Short Term Course (1) at WALMI, Aurangabad". Operation System on MIS, Pune, India, Undt.

21. Liaison and Coordination Unit, USAID assisted MMI Project (386-0490) "OPERATION PLAN, Planning Operation and Evaluation", August, 1990 USAID, Pune, India

22. Liaison and Coordination Unit, USAID assisted MMI Project (386-0490), "SYNOPSIS of Diagnostic Analysis of Twelve MIS" June, 1989, USAID, Pune, India

23. Liaison and Coordination Unit, USAID assisted MMI Project (386-0490), "Work Plan for Organizational Efforts In Formation of WUAs", USAID,Pune, March, 1991.

24. Liaison and Coordination Unit, USAID assisted MMI Project (386-0490), "Guidelines for Designing Training Plan", April, 1987, USAID, Pune, India

25. Liaison and Coordination Unit, USAID assisted MMI Project (386-0490), "Achievements and Activities", June, 1991, USAID, Pune, India.

26. Liaison and Coordination Unit (USAID) Maharashtra Minor Irrigation Project Cont. No(386-0490), "Minor Irrigation Scheme - Construction Status", Bench Mark Achievement, Laison and Coordination Unit (USAID), Pune, India, June, 1991

27. Liaison and Coordination Unit (USAID) assisted Maharashtra Irrigation Programme, "Computer Site Visit - Tour Reports" J.W. Fredricks, July 1989, Pune

28. Liaison and Coordination Unit USAID Assisted Maharashtra Minor Irrigation Project Cont. No (386-0490), "User Manual Minor Irrigation, Data Base Management System", Pune, India, July, 1990

29. Liaison and Co-ordination Unit, USAID/MMI Cont. No(386-0490) User Manual, "Management Information System for Monitoring and Evaluating State Sector Minor Irrigation Schemes", Sheladia Associates Inc, Pune, India, July 1990

30. Liaison and Coordination Unit, USAID/MMI Cont. No.(386-0490) "Computer Program Yield, Rainfall-Runoff Correlations Spread Sheet", Sheladia Associates Inc., Pune, India, June, 1990

31. Liaison and Co-ordination Unit, USAID/MMI Cont. No.(386-0490) "Hydrologic Data Base Management System" - User Manual Version 1.1. Sheladia Associates Inc., Pune, India, August, 1990

32. Liaison and Coordination Unit, USAID/MMI Cont. No.(386-0490) "Computer Program RAIN, Spreadsheet to Estimate Fortnite Rainfall Distribution", Sheladia Associates Inc., Pune, India, June, 1990

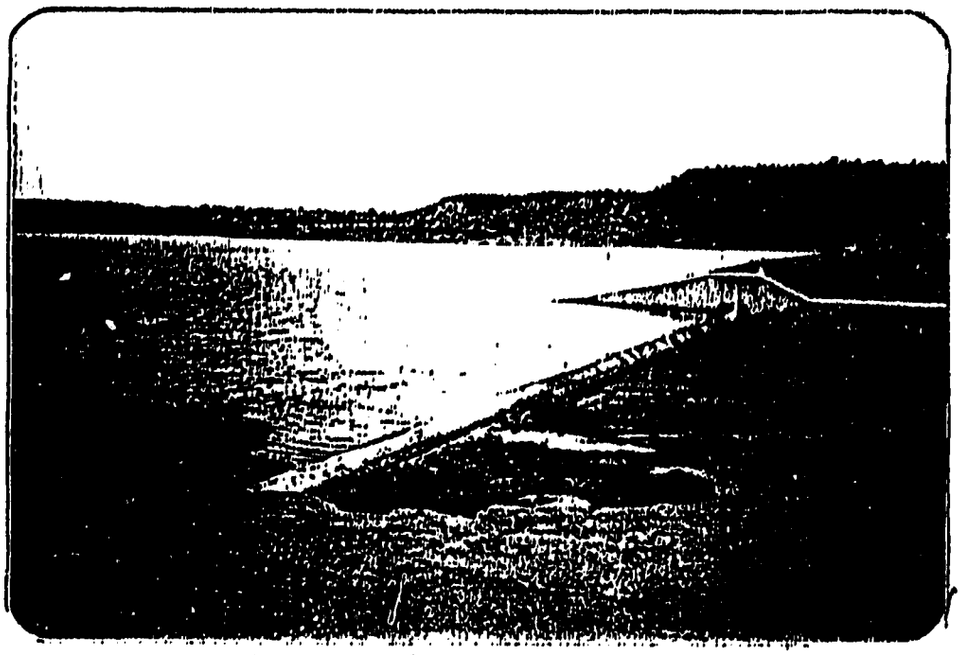
33. Nagpur Irrigation Department, "A Note on Computer Activities in Nagpur Region", GOM, 1991 MIMEO 40. Nagpur Irrigation Circle - Operation Report of Wakeshwar Minor Irrigation Scheme (Rabi - 1990/91) Taluka - Nagpur District Nagpur 1991

34. Nagpur Irrigation Circle - "Operation Report of Telhara Minor Irrigation Scheme (Season - Rabi 1990-91)", Taluka, Hingana District, Nagpur 1991

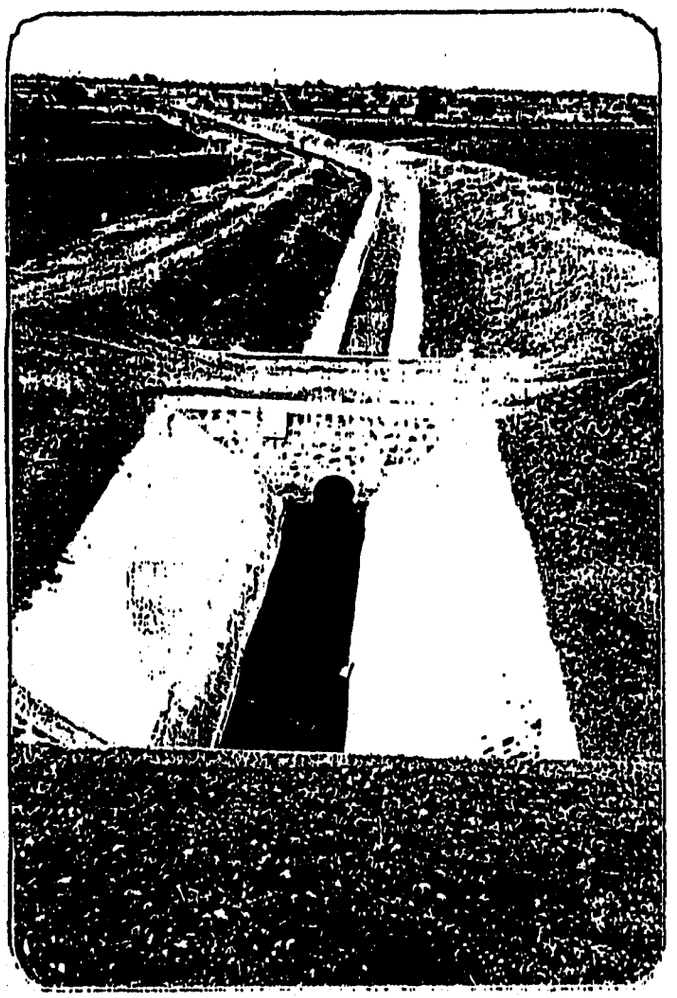
35. Sheladia Associates, Inc., "Final Report", MMI Project, USAID, 386-0490, December, 1990

36. Special Appraisal and Supervision Cell, Irrigation Department "Parunde Minor Irrigation Scheme Appraisal Report, Report No.3 USAID/MMI Project, Irrigation Department Mantralaya, Bombay, India

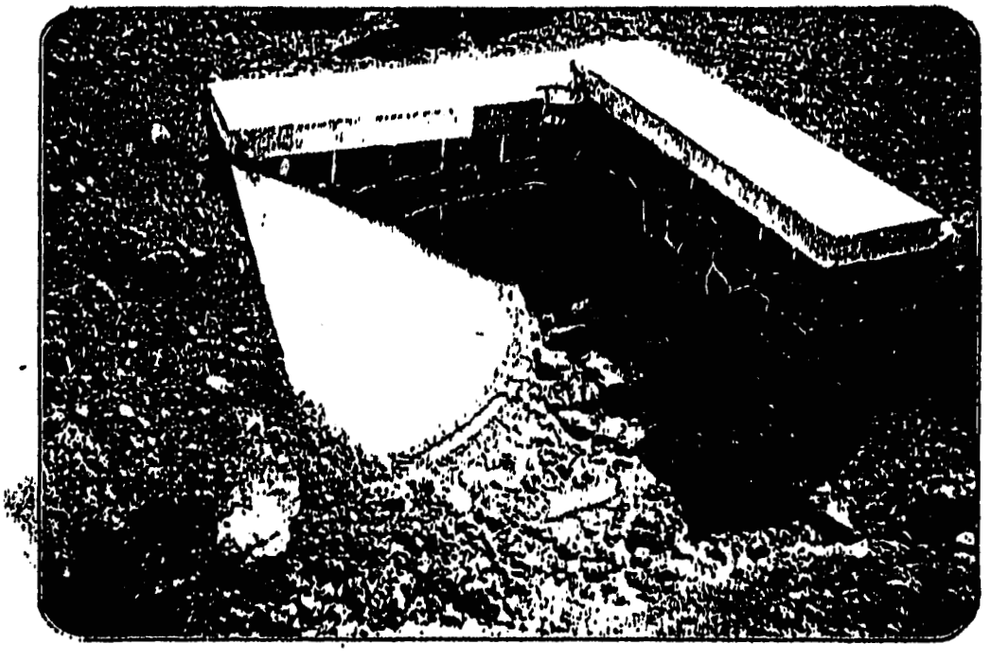
37. Water Management Synthesis II, USAID, "Maharashtra Irrigation Program Assessment Report", India, USAID, WMS Report 91, July 1987.



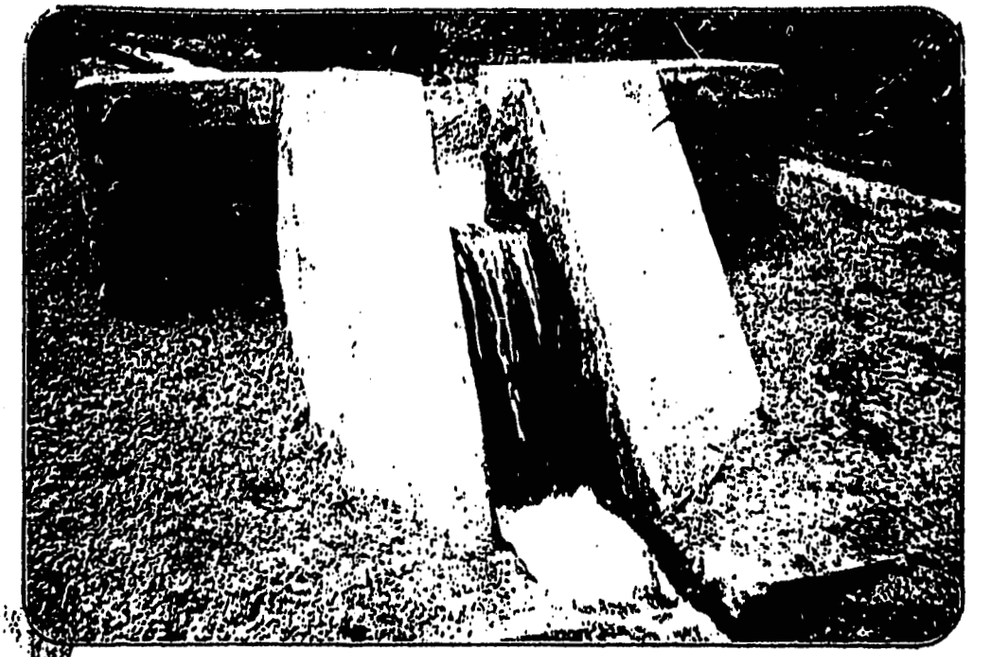
Loni MIS spillway crest and earth dam



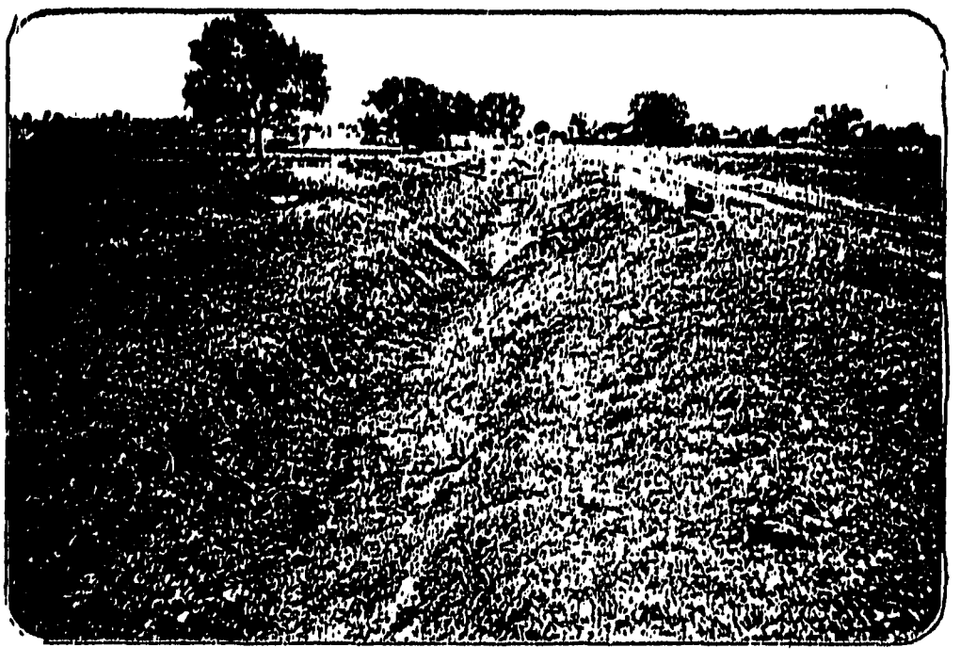
Head reach of the main canal of Wadegaon MIS showing robust construction



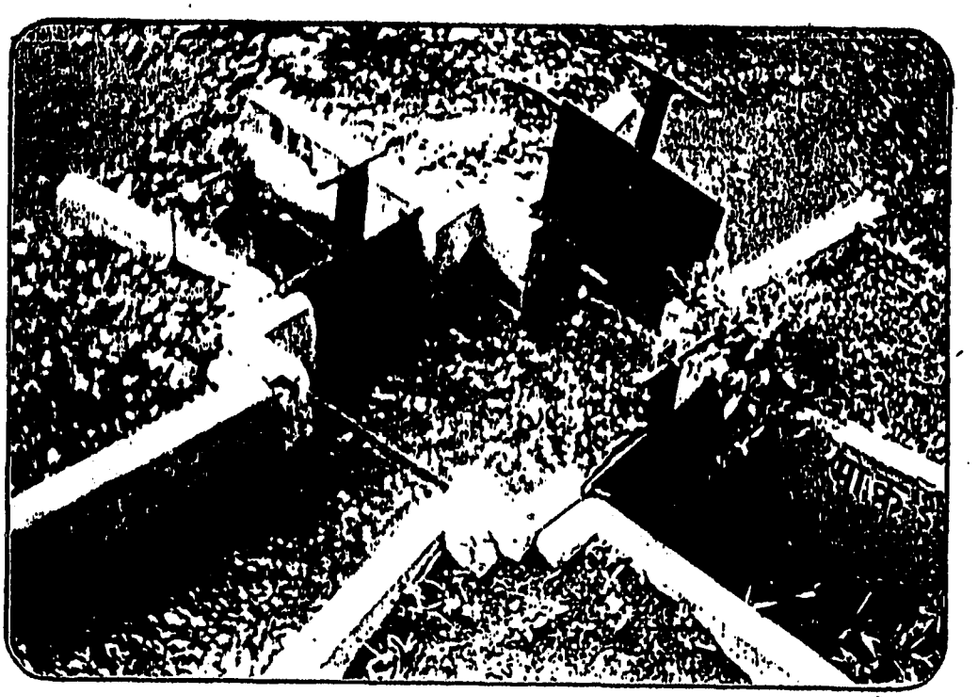
An outlet from main canal to chak in Singvi (Shirval) MIS



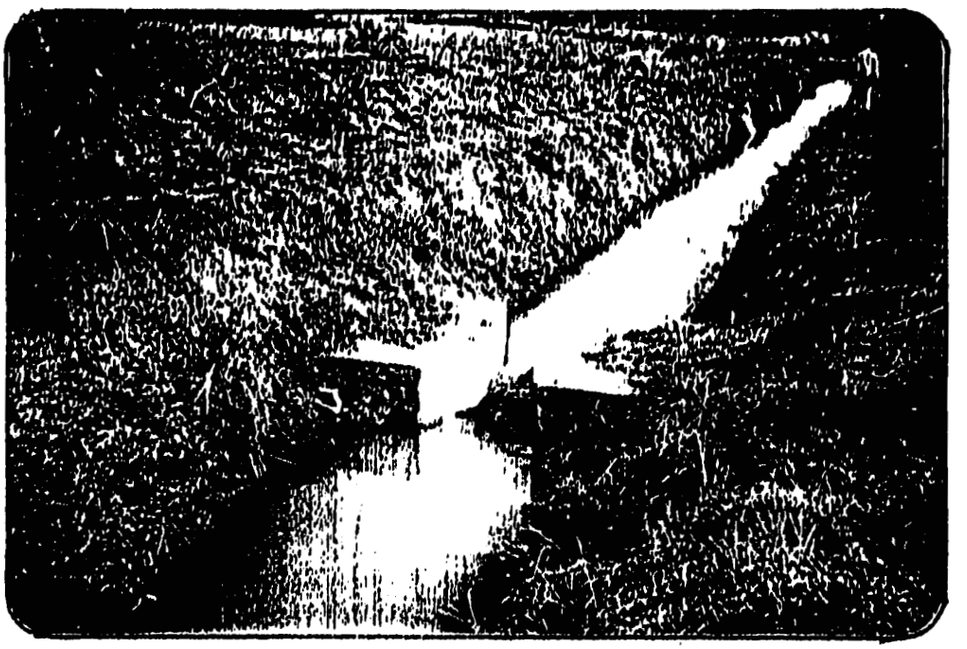
A straight drop structure in the main canal
of Loni MIS



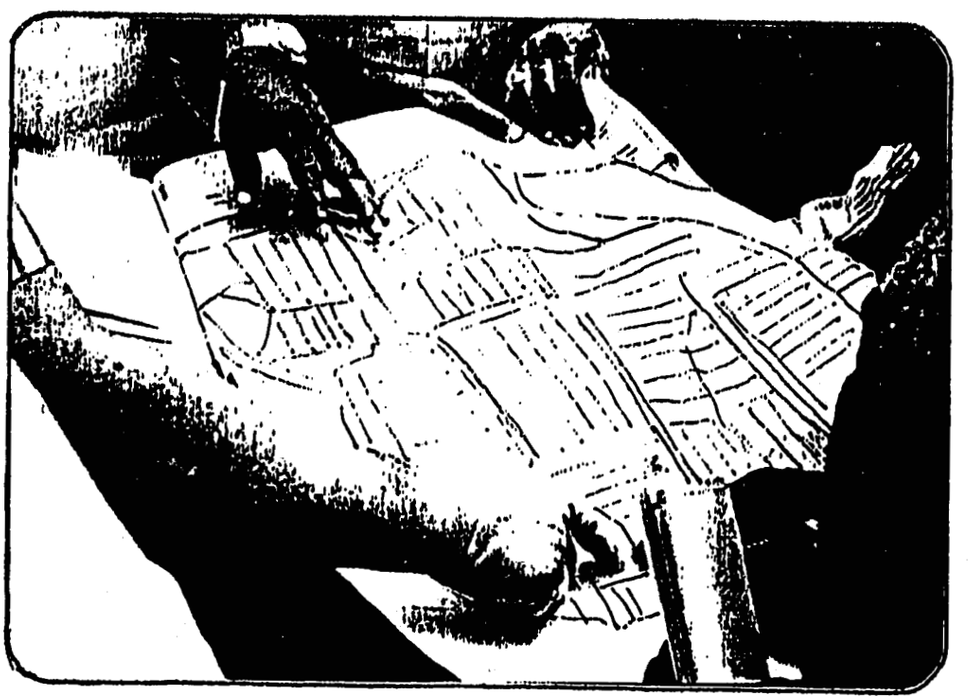
A well maintained field channel showing profile wall



A precast division box in Wakeshwar MIS

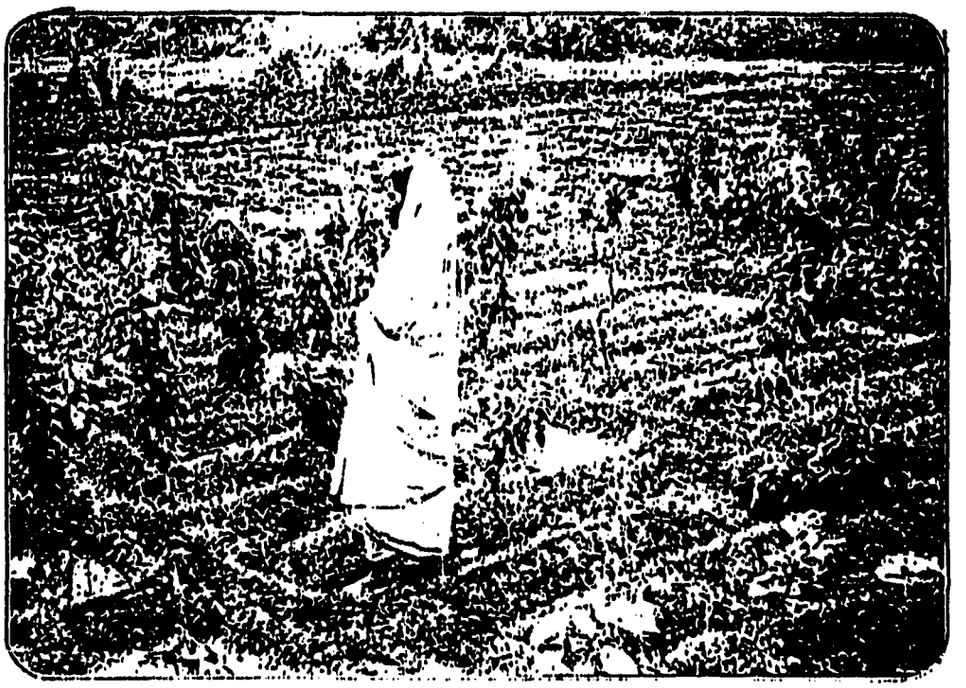


A masonry cut throat flume constructed to measure the discharge



Irrigation engineers explaining rotational water supply scheme

Sowing groundnut using an improved bullock-drawn seed planter in Sangvi (Shirval) MIS



Small basin irrigation and involvement of women in agriculture