IRRIGATION SECTOR STRATEGY REVIEW

INDIA

USAID

WATER MANAGEMENT SYNTHESIS II PROJECT

WMS REPORT 35

IRRIGATION SECTOR STRATEGY REVIEW

USAID/INDIA

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PREFACE

This study was conducted as part of the Water Management Synthesis II Project, a program funded and assisted by the United States Agency for International Development through the Consortium for International Development. Utah State University, Colorado State University and Cornell University serve as co-lead universities for the Project.

The key objective is to provide services in irrigated regions of the world for improving water management practices in the design and operation of existing and future irrigation projects and give guidance to USAID for selecting and implementing development options and investment strategies.

For more information about the Project and any of its services, contact the Water Management Synthesis II Project.

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FOREWORD

This Irrigation Sector Evaluation and Strategy Review was conducted at the request of USAID/India through a "buy-in" arrangement with the Water Management Synthesis II Project (WMSP). USAID India's program in irrigation began in 1978 and now represents a cumulative commitment of $315 million. The Mission's strategy has been continuously reviewed in its annual CDSS (Country Development Strategy Statement), but these are "in-house" exercises. The Mission and Asia Bureau of AID/W both felt that an in-depth review by an outside group during 1984-85 would be very desirable as one important input for future strategy planning, especially considering the size of the program, the complexity of the irrigation sector and the implied long-term commitment.

AID and WMSP agreed that the three principals would be solely responsible for the evaluation. The principals were supported by three associates, one of whom had been involved in the development of the present irrigation program, one who had past involvement with general USAID/India strategy and a social scientist with considerable previous Indian experience.

The studies were conducted in India during October-December 1984. The Team visited sites and conferred with Indian officials, institutional leaders and irrigation authorities at the Center and in Maharashtra, Madhya Pradesh, Rajasthan and Tamil Nadu, and at the Indian Institute of Management in Bangalore, and made extensive reviews of project documents and other relevant literature.

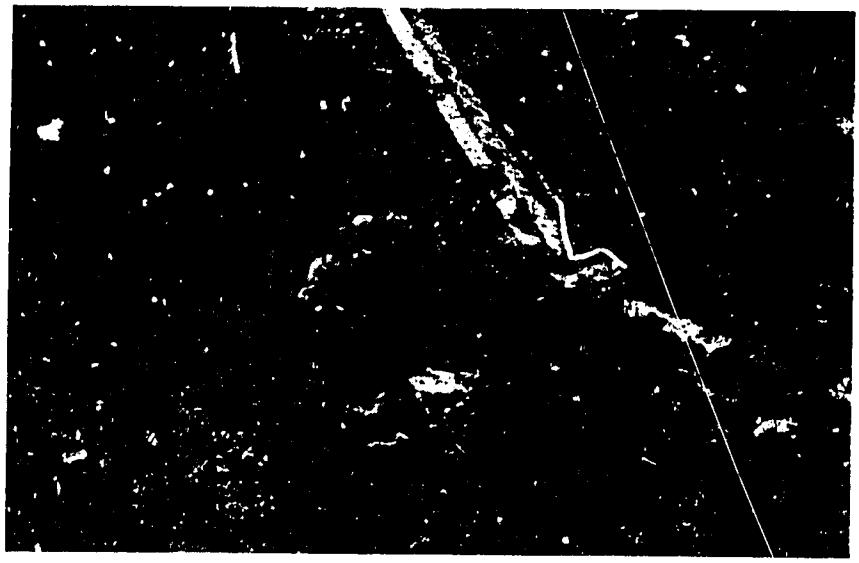
The Team gratefully acknowledges the assistance of GOI and State officials and many others in India including, in particular, Mahatma Phule Agricultural University, Ford Foundation and World Bank (India), USAID/India, and AID/W Asia Bureau and Science and Technology staffs. Regretably, all of those deserving acknowledgment are too numerous to mention personally here. The Team is particularly grateful for the support and advice of Mr. Owen Cylke, Director, and Mr. William H. Janssen, Associate Director for Agriculture, USAID/India and their staff members; and to Dr. Mark Svendsen and Dr. Douglas Merrey, AID/W ASIA and S&T, respectively, and to Dr. Michael Walter, USAID/India, who reviewed and commented on the draft manuscript.

Photograph Series from Field Visits

Index

Photographs by Judith Keller

1a. Simple rock diversion in small mountain stream.



1b. Lined channel on steep slope.

1c. Carefully terraced fields on steep slopes.

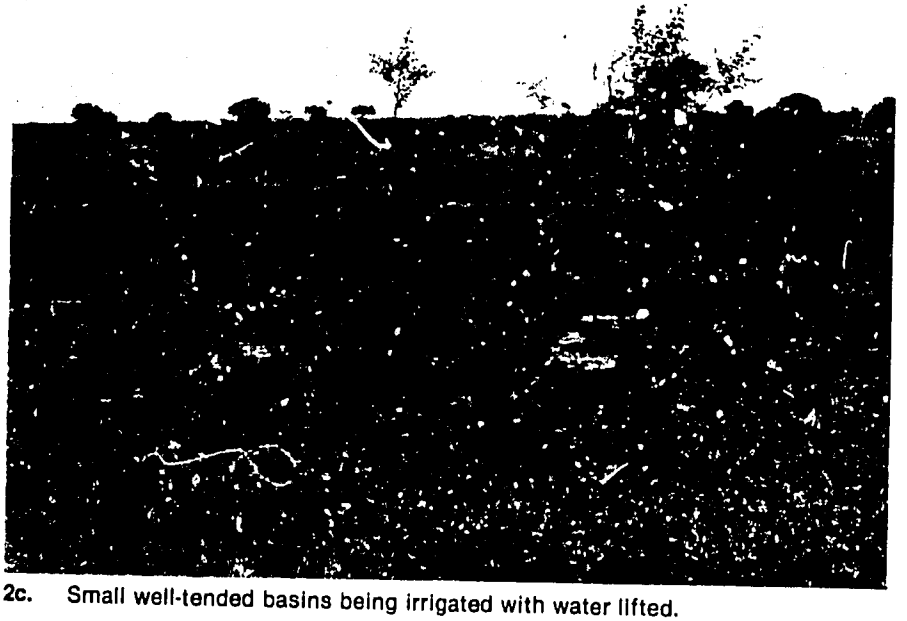
Photograph Series 1

Community-operated hill irrigation:

Typical community irrigation system near Nanital. The diversion is simple and must be rebuilt after heavy streamflows. The lined channel on the steep hillside was constructed by the Irrigation Department. However, the people in the community serve both as the managers and maintainers of the system to irrigate the terraced fields.

2a. Bullock starting down ramp to lift water from a dug well.

2b. Water spilling from opened bottom of leather bucket.

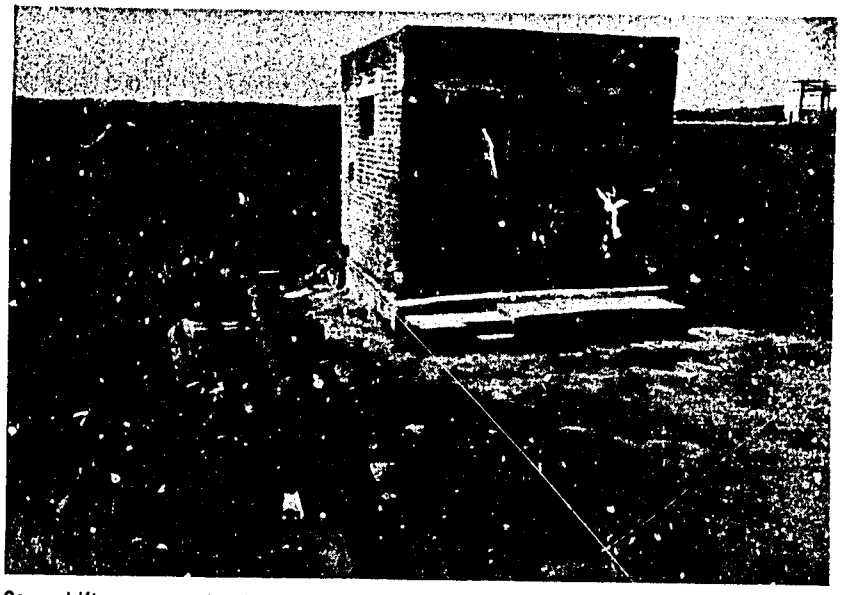


2c. Small well-tended basins being irrigated with water lifted.

Photograph Series 2

Animal-powered dug-well irrigation:

This is one of the 1,100 dug-well irrigation systems within the command area of the Sena Medium Irrigation Project in Maharashtra. A relatively small quantity (less than 3 lps) of water is lifted by bullocks for several hours in the morning and evening. Typically, these flows are carefully utilized to irrigate well-tended small basins. Under many conditions it is easier to manage these small flows than the larger flows of 30 lps which will be delivered on a rotational basis by the Sena Project.

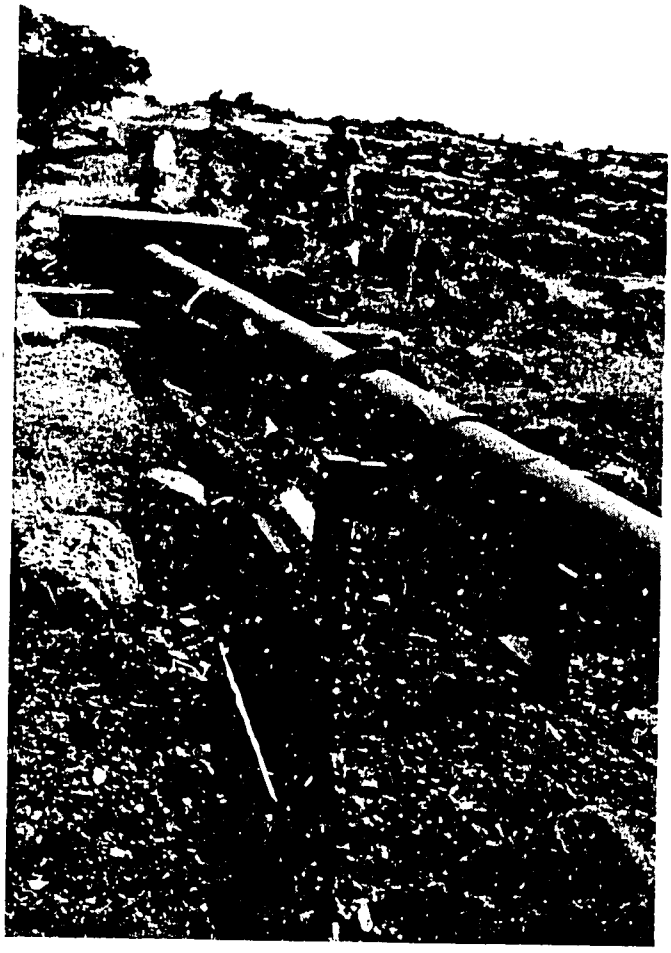


3a. Lift pump station in large reservoir.

Photograph Series 3

Lift irrigation scheme:

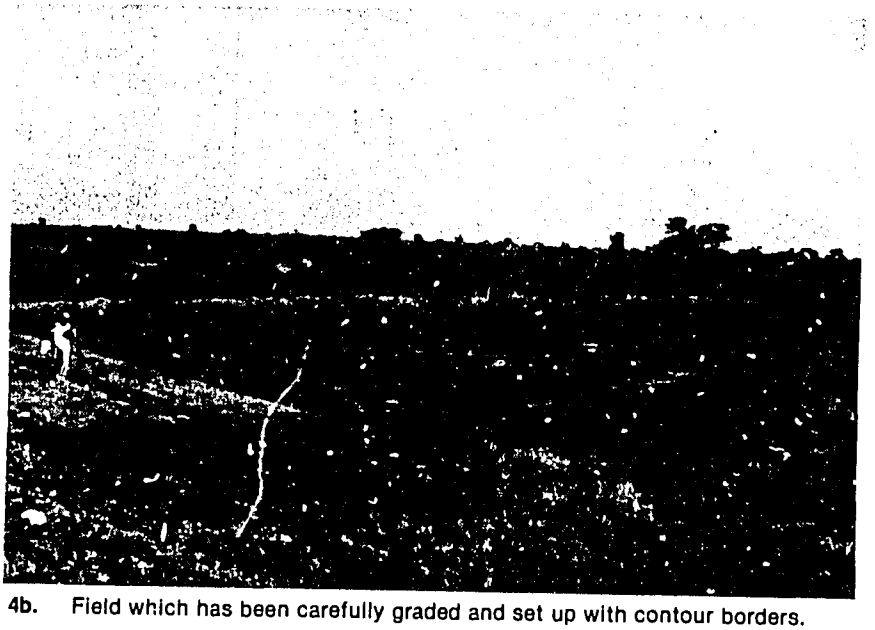
Lift pump station on Mahatma Phule University campus at Rahuri, Maharashtra. The electric pump lifts water through the penstock to the top of the hill. From there the water is conveyed in an open channel to the irrigated fields.



3b. Penstock from pump station to open channel.

3c. Canal at top of hill serving irrigated fields.

4a. Farmer busy trying to irrigate with a large irrigation stream between borders on an ungraded field.



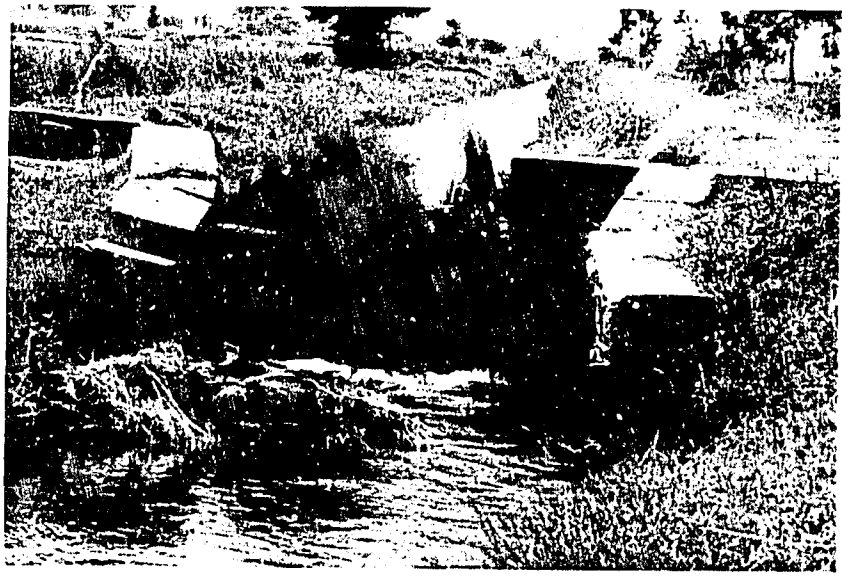
4b. Field which has been carefully graded and set up with contour borders.

4c. Large well-irrigated field of grain sorghum.

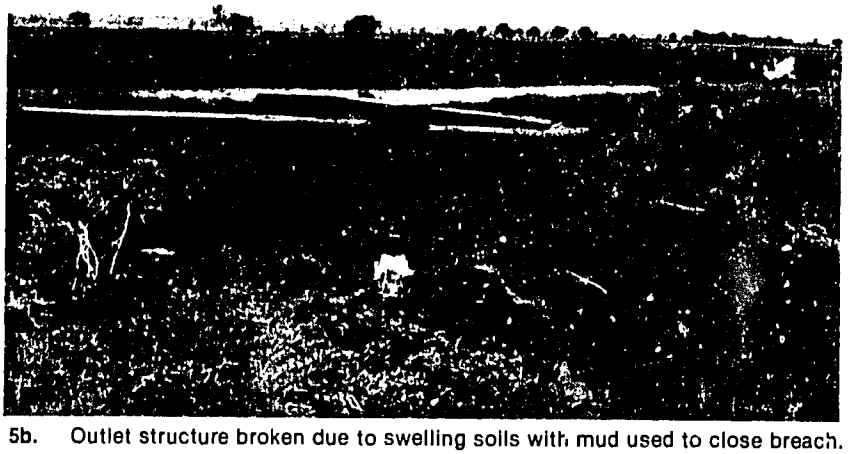
Photograph Series 4

Contour grading to improve water distribution:

It is quite difficult to irrigate with a large 30 lps flow of water on an ungraded field. To handle the large flow the field must also be quite large; however, the uneven surface makes even distribution impossible. Therefore, where large flows are to be applied the field must be graded and laid out according to the contours. When this is done, irrigation can be quite uniform, resulting in good production made possible from the resulting uniform crop.



5a. Straw used to check a canal drop structure which was broken by swelling clay soils.



5b. Outlet structure broken due to swelling soils with mud used to close breach.

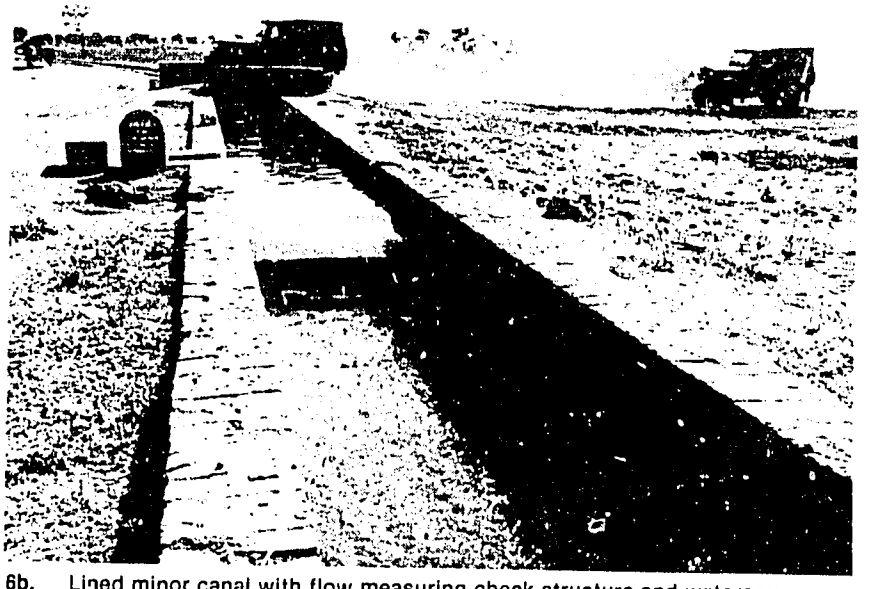
5c. Irrigation channel causing cross drainage problems and waterlogging.

Photograph Series 5

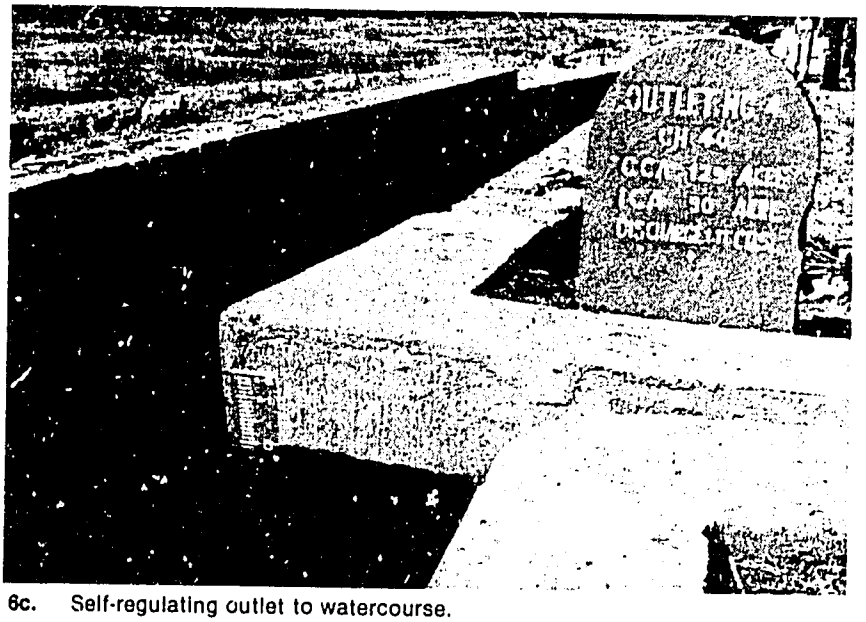
Problems with swelling soils and waterlogging:

At the Dahod Tank Minor Irrigation Project near Bhopal the soils swell when wetted and shrink when they dry. This causes serious problems, as shown in the top two photographs. There are construction techniques which can be used to alleviate the problem, but they are expensive. Farmers typically take care of situations with the materials which are available, such as straw, sticks and mud. Another typical problem is associated with water-logging caused by the canals and because of seepage and the obstacles the irrigation channels present to surface drainage.

6a. Gated takeoff from main canal to minor canal.



6b. Lined minor canal with flow measuring check structure and watercourse turnout.

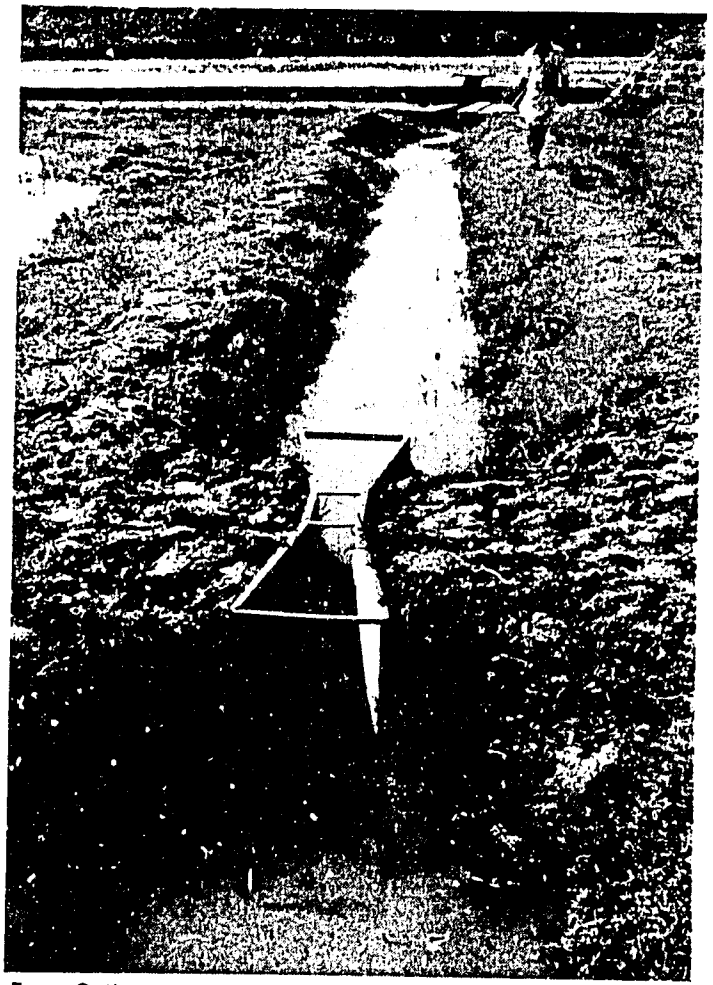


6c. Self-regulating outlet to watercourse.

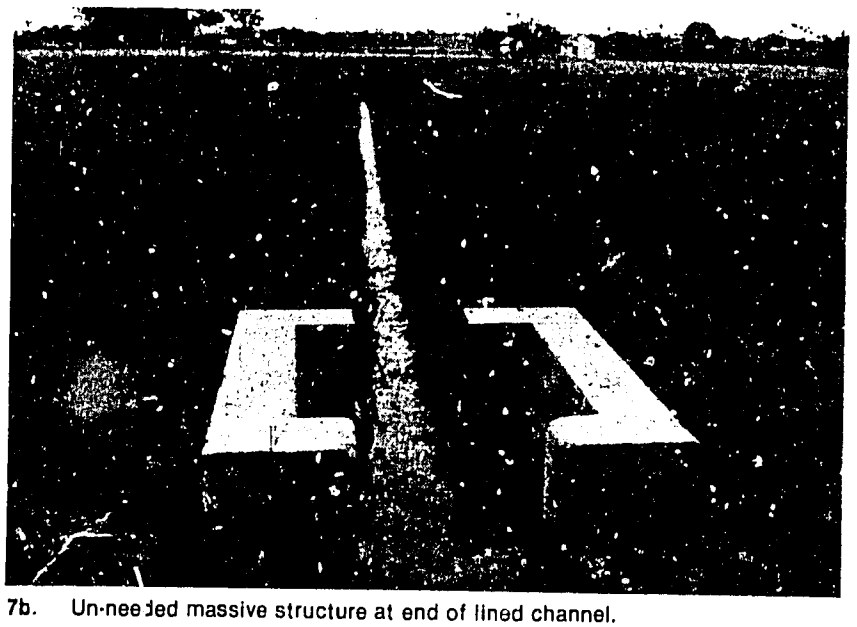
Photograph Series 6

Self-regulating outlets along minor canal:

This is the Thikaria Minor which is 1,700 ft. long and serves 1,900 acres on the Gambheri Medium Irrigation Project in Rajasthan. Once the gated offtake at the head of the minor is properly set, all of the outlets discharge the prescribed quantity of water in accordance with the irrigated command area (ICA) served. The checks in the minor channel also serve as measuring devices. Each outlet is provided with a gauge with zero marking the appropriate water line. There are 17 outlets on the minor and all farmers are free to inspect the water level at each outlet and thus police the system.



7a. Outlet notch in the overflow spillway and flume for measuring flow from the outlet.



7b. Un-needed massive structure at end of lined channel.

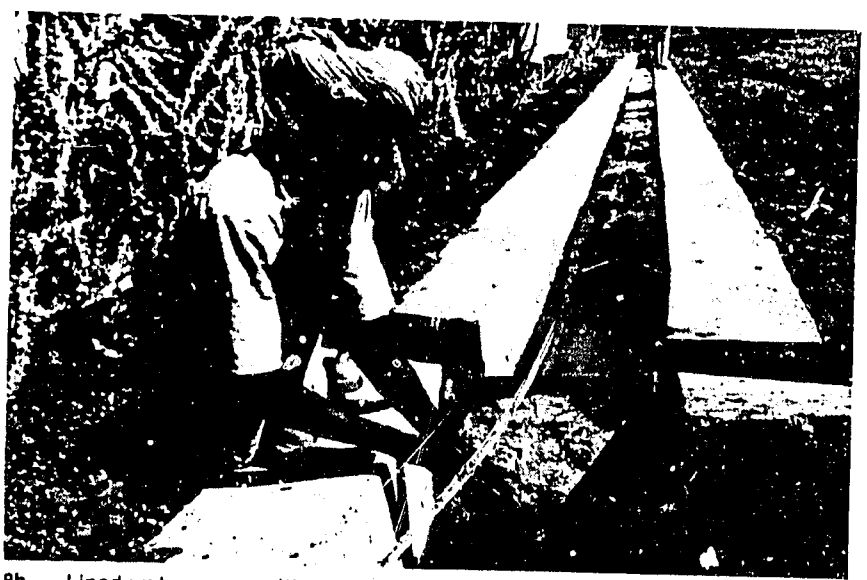
7c. Discussing the research study.

Photograph Series 7

Small-scale irrigation project study:

This is the site of an intensive research study of the Padianollur Tank near Madras. The tank has an area of 100 ha and the average reservoir depth is only 1.5 m. There are four outlets, each with a different diameter and elevation, and there are 38 wells within the 600-acre command area, approximately 400 of which are irrigated. Intensively studying this small project has revealed the very complex nature of the intriguing interactions between the physical and social aspects of irrigation projects, regardless of size.

8a. Improvised field turnout from unlined watercourse.



8b. Lined watercourse with stone slab check and earth plug in field outlet.

8c. Watercourse outlet structure with circular closure blocking outlet and allowing water to flow by.

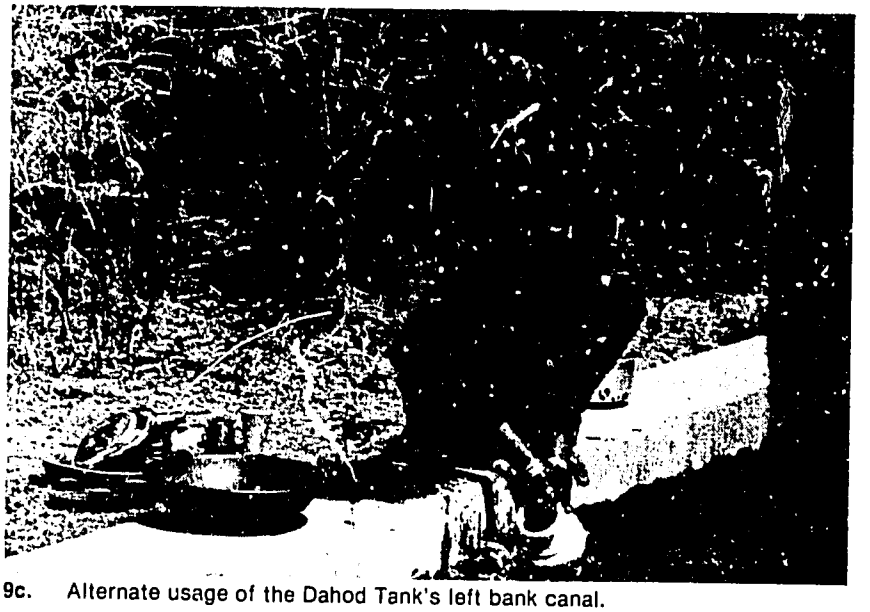
Photograph Series 8

Watercourse outlets:

Much water is lost from the entire canal distribution because of leakage from the outlets. Without using structures it is very difficult to control this leakage. Usually structures are provided along the larger canals, but typically the field outlets along the watercourses are not provided with structures, so the farmers must improvise a means for shutting off the flow. Several interesting watercourse outlet structures are being tried within AID's medium irrigation project in Rajasthan. The structures using stone slabs are a definite improvement and quite inexpensive; however, the circular outlets (while more expensive) offer an even more effective solution.

9a. Farmer using a 4-inch diameter hose to convey water to high spots in his large ungraded field.

9b. Construction workers and supervisors at the Sena Medium Irrigation Project dam's spillway.



9c. Alternate usage of the Dahod Tank's left bank canal.

Photograph Series 9

Additional thoughts:

The human enterprise of irrigating offers an endless challenge for innovativeness. Since free-flowing water runs only downhill, the farmer pictured here elected to pump water through a hose to high spots in his field. The construction of irrigation infrastructure provides important employment opportunities for the landless and underprivileged members of society. Even when irrigation systems fall far short of providing the hoped-for agricultural benefits, they usually provide an important commodity, "ponded or running water," to the communities they are in contact with.

EXECUTIVE SUMMARY

Arrangement of the Report

The main report Chapter I, begins with a review of the food and agricultural situation in India generally and as related to irrigation. Chapter II is an examination and description, including responsibilities of the principal irrigation institutional actors, primarily GOI and State agencies, but includes some references to communities and non-governmental agencies when these are involved. Chapter III, the principal evaluative chapter, assesses the principal effects that AID's program has had on institutional change and on technology transfer. This chapter identifies some of the major problems confronting the present program, and irrigation development more generally, and assesses their likely future affects also. A look at constraints and assumptions pertinent to future programs is contained in Chapter IV. Chapter V makes a number of suggestions as means for improving implementation of the present program now still largely in its early stages. Chapter VI makes some general program recommendations, suggests four possible new program/project models and comments on the future of the present ongoing program.

Two Annexes are bound with the report. The first independently discusses various points and arguments made by the main report. The second reviews the potential of and suggests a strategy for groundwater development in the Deccan area. These contributions represent the views of their respective authors.

Appendices are separately bound for more limited distribution. These were developed as background pieces for the Team and include descriptions of irrigation institutions in Madhya Pradesh and of the arrangements and responsibilities of Central Government agencies; the historical development of the Mission's current irrigation portfolio; background for socioeconomic effects of the present portfolio; historical trends and irrigation policy issues in India with emphasis on the Deccan States; selected productivity, equity and economic issues in India; and recurrent costs of operation and maintenance of irrigation systems in Maharashtra. Like the Annexes, these papers also represent the views of the individual authors.

OVERVIEW OF THE INDIAN FOOD AND AGRICULTURAL SITUATION AND THE ROLE OF IRRIGATION

Nutritional Supply and Demand

Foodgrains

During the period from the 1920s to the 1950s per capita food grain availability in India dropped from about 700 grams/day to a low of 385 grams/day in 1952. Following this period growth rate rose steadily, although it appeared to stagnate in the late 1970s. From 1951 to 1968

the growth was attributed to expansion of irrigation, and thereafter largely to "Green Revolution" yield increases. There is reason now to question the reality of the late 1970 stagnation; rather, growth to date appears to have been at a reasonably increasing trend.

Other Food Products

Comparisons of food availability based on production with "least-cost adequate diet" shows that overall foodgrain production is adequate, but that large (77 percent) deficits exist for other foods, primarily in fruits and milk, with more moderate ones for fats and oils and fish and meat. Because of unequal distribution there are large populations which have not reached adequate dietary levels even for foodgrains, however. Overall, India does not seem to be nearing nutritional self-sufficiency. Food production will need to increase by perhaps 50 percent to provide the population a least-cost adequate diet. Though major deficits are elsewhere, increased foodgrain production will also be necessary.

Market Supply and Demand

Though transition from a subsistence to a predominant market economy has not been rapid, per capita income has risen, albeit slowly. Market forces appear to be pulling production in the same direction that nutritional demand dictates. Stagnation of foodgrain demand seems to occur at levels just below the average per capita income. Increases in income above that level are associated with a high income elasticity of demand for non-foodgrain items, but people with lower incomes will continue a market pressure on foodgrains. The long-term trend should be toward reversing the product composition from 60 percent grains and 40 percent other products to 40 percent grains and 60 percent other products.

External markets could have some effects. Its basic factor endowments, scarce land and capital and abundant labor, make India a poor competitor in international grain, meat and milk markets, but places the country in a good position for many fruit and vegetable products. However, poor marketing/processing technology and marketing infrastructure would appear to place major constraints on rapid export expansion of these products.

The Role of Irrigation

Peter Rogers found that during the period 1901 to 1970 average foodgrain yields correlated well with irrigation. During the 1960s irrigation, especially because of groundwater development, shifted toward higher intensities. Ashok Mody estimates that during the 1950s three-fourths of the increases in production due to irrigation came from canal schemes, with one-fourth from groundwater. During the 1960s these numbers were reversed.

By 1980 34.6 million hectares of surface irrigation potential, i.e., commanded by canals, had been created and 22 million hectares were irrigated by groundwater. Virtually all groundwater development is in the private sector, but the reverse is true for canal irrigation. Only about half of the canal potential is utilized. On this basis, canal irrigation accounts for about 44 percent of all irrigation with groundwater accounting for 56 percent. The affect of groundwater irrigation on production is further amplified because of its higher reliability. Besides contributing directly to yields, this stimulates greater investments in inputs by farmers. Estimates made by V.M. Rao and M.G. Chandrakant are that the gross value of well irrigation, on the average, is about 1.8 times that for canals and tanks. Combining the effects of low utilization of canal potential and high productivity of well water leads to the conclusion that in the early 1980s about 70 percent of irrigated production was from groundwater and 30 percent was from surface irrigation.

There is growing evidence that India's groundwater potential is much larger than previous estimates, such as those used in the Sixth Plan, which projected 40 million ha total, or 18 million more to be developed. The Central Groundwater Board has substantially increased its estimates. One unreferenced source puts the potential from groundwater at 72 million ha. Besides its other advantages, groundwater costs less to develop and investments are much more divisible. A shift toward greater emphasis on groundwater would further stimulate the production of high value crops such as those for which India has nutritional deficits. These considerations raise important issues for public irrigation investment which can only be reached through public policy analysis inside a much improved framework of social benefit/cost analysis.

IRRIGATION INSTITUTIONS AT THE CENTER AND IN SELECTED STATES

An important point in the discussion of irrigation institutions in India is the constitutional arrangement that allocates the responsibility for irrigation development to the States. Besides the Center, institutional arrangements in Maharashtra, Madhya Pradesh and Himachal Pradesh are discussed. An important point made is that there are significant and vital parts of irrigation outside the purview of the mainline Irrigation Departments. Most obvious is the private sector in which groundwater supplies are developed and utilized. While influenced by governmental policies, this sector nevertheless enjoys considerable freedom; however, this freedom is sometimes curtailed in canal systems managed by the States. The scope and importance of the various sectors is discussed in other chapters.

Another, but less visible sector, is the "local irrigation sector," usually involving small gravity or lift systems under the control and management of local groups such as village or district panchayats, or independent water user groups. About 5 percent of the total irrigation

has been developed under this sector. While autonomous with regard to Irrigation Departments, these groups may receive financial and technical assistance from other government agencies such as the Department of Agriculture or of Rural Development.

AID's irrigation projects must operate in various institutional settings; each State setting has a common "Indian" institutional style, but simultaneously may exhibit variations reflecting historical and contemporary local conditions.

Institutions at the Center

Ministry of Irrigation

Except for small projects under local jurisdiction, surface irrigation is publicly-financed largely by allocations from the Center to the States. The principal actor in the process at Center level is the Ministry of Irrigation, which is headed by a politically-appointed Minister supported by a Secretary for Irrigation and his staff. Primary functions of the Ministry are advising the Cabinet, Parliament and the Planning Commission on the allocation of resources to the various States and initiating new approaches to irrigation development and management.

Technical control of project planning and design is exercised through an arm of the Ministry, the Central Water Commission (CWC), which is headed by an Engineer with the rank of Secretary. The CWC reviews project proposals received from States for technical compliance with their standards and cost estimates. All projects over 2,000 ha in size (major and medium projects) participating in Central financing are so reviewed. When found satisfactory, projects are certified to the Planning Commission for ultimate sanction. For externally-funded projects, including AID's, CWC has set up special appraisal committees who review these projects for compliance with additional criteria agreed to under loan/grant agreements and monitor compliance and progress in the field. Besides its review assignment, CWC also develops and introduces new technology and techniques through its planning and design standards.

The Center does not review individual minor projects, nor are these referred to the Planning Commission, but it does exercise influence on standards, especially on externally-funded projects through its minor irrigation development unit. A command area development unit serves a similar function with regard to Command Area Development Authorities (CADAs). Overall policy and programming for groundwater development and overall monitoring and assessment of groundwater development and potential are the functions of an interdepartment Central Groundwater Board housed in the Ministry of Irrigation.

A further comment on CADAs may be merited. CADAs were conceived during the early 1970s in response to a perceived need for accelerating irrigation development activities below public outlets. Separate CADAs

are in place on large major projects. The forms that CADAs take vary from State to State, particularly in relation to the powers given to the CADA administrator. Most CADAs are set up in State Agricultural Ministries, but this also varies.

Ministry of Agriculture

Like irrigation, agriculture is a State subject. The principal function of the Ministry of Agriculture as far as irrigation is concerned is coordinative. It assists the States with planning, budgetary and policy support functions.

The Indian Council for Agricultural Research (ICAR) is a registered society under the Societies Registration Act. The President is the Minister of Agriculture. The Director General of ICAR is also the Secretary for the Department of Agricutlure Research and Education in the Ministry of Agriculture. ICAR provides countrywide coordination for research, education and extension education in agriculture. It also provides financial, technical and management support for research carried out at State agricultural universities, national research centers and institutes, all-India coordinated research projects and various ad hoc research projects throughout India. ICAR activities are primarily directed at controlled research on various components of water management at the station, field plot or farm level.

Planning Commission (Ministry of Planning)

The Planning Commission, chaired by the Prime Minister, is responsible for both the long-range development strategy and the allocation of budgetary resources. It sets medium-term development goals in its Five Year Plans, attempts to coordinate supporting roles among various divisions and activities, sets policy and allocates fiscal year budgets. Funds from external sources are included in revenue projections for the plan against which budgets are balanced. Thus, foreign assistance funds are not budgetary add-ons, but must be included within the planned ceilings and appropriations.

Other

The Department of Economic Affairs in the Ministry of Finance coordinates all external assistance programs including the technical and legal details of fiscal transfer and accounting, loan agreements, etc. The University Grants Commission (Ministry of Education) coordinates allocations of central funds to universities. The Agricultural Refinance and Development Corporation (ARDC) provides credit for well and lift irrigation development including electrification) and for chak and farm level land development. The ARDC receives capital allocations from the

Center and dispenses credit through a network of State, district and local level development banks.

State Institutions for Irrigation

As mentioned earlier, State irrigation institutions are smaller State-wise, but with some important differences. Institutions for the three State studies are summarized below.

Status of Irrigation Development

Both Maharashtra and Madhya Pradesh irrigate approximately 2 million ha, or 11 percent of their cultivable areas. Himachal Pradesh has about 100,000 ha, or 16 percent of its net cultivated area, under irrigation. In Maharashtra groundwater serves 60 percent of the irrigated area, but only 43 percent in Madhya Pradesh. Irrigation in Himachal Pradesh is largely served by surface diversions from smaller streams and springs. In Maharashtra minor irrigation accounts for about 74 percent of the irrigated area and nearly all of it in Himachal Pradesh.

Private and Local Sector

In Maharashtra the private sector is growing at about 5 percent per year, largely in groundwater, but also from lift schemes. Much of the development impulse in the sector comes from the direct financial and organizational involvement of processing and marketing cooperatives, particularly sugarcane so far, but with other commodities such as grapes and onions also in recent years. In contrast, the private sector in Madhya Pradesh is not yet being driven by the involvement of commodity and marketing groups. Most of the irrigation (probably 75 percent or more) in Himachal Pradesh was developed by the communities themselves, but communities have increasingly looked to the State Irrigation Department to assist them in needed rehabilitation. In Maharashtra local entities such as panchayats are responsible for surface schemes serving less than 100 ha (about 5 percent of the area irrigated). In Madhya Pradesh this limit is set at 40 ha. Irrigation Departments have responsibiities for larger schemes. There are no similar size limitations in Himachal Pradesh; the Irrigation Department may provide service to areas as small as one hectare, and there is no ceiling on the size that communities may construct and operate, though these seldom exceed a few hundred hectares. Financing through institutional credit is the common mode in Maharashtra and Madhya Pradesh. In Himachal Pradesh this is more commonly provided by the Agriculture Department.

State Sector

Both Maharashtra and Madhya Pradesh have large well-developed Irrigation Departments headed by a politically appointed Minister or

Ministers, supported by one or more Secretaries, usually engineers. In Maharashtra Command Area Development is organized under the Irrigation Department with its own Secretary, in contrast to most States where it is assigned to the Agriculture Department. The Maharashtra Irrigation Wing has six regions, each under a Chief Engineer who is responsible for field operations from planning through design and construction to operation, maintenance and management for major, medium and minor systems in the public sector. Separate Special Chief Engineers are appointed for large projects. Supporting staff at headquarters is organized divisionally under (usually) three Chief Engineers (the number may vary according to need). In Madhya Pradesh the activities are divided among three Ministers for Medium and Major Irrigation, Minor Irrigation and Major Projects in the Narmada Basin. Each division has a Secretary and the common array of Chief, Superintending, Executive, Assistant and Sub-Engineers supporting them. In Himachal Pradesh irrigation is organized under one Chief Engineer in the Public Works Department, who also has responsibility for public health. Normally, IDs, under GOI policy, have responsibility for construction and OM&M down to outlets serving about 40 ha. Below that, farmers are responsible. Recently GOI asked State IDs to construct channels down to 8 ha levels, but this is being implemented slowly due to financial difficulties, except on externally-funded projects.

In Maharashtra technical support for groundwater development is provided by the Groundwater Development Agency, which is well staffed with competent professionals. In Madhya Pradesh, this function is set up in the Irrigation Department under a separate Chief Engineer for Groundwater Surveys.

The roles of Agriculture Departments are mainly supportive. In Maharashtra the Soil Conservation Division normally provides techical support for developments such as watercourses and field channels, and land leveling on farms below public (40 ha) outlets. For externally-funded projects only, this responsibility has been taken over by ID down to farm gate, or 2 ha level. In Himachal Pradesh both the Agriculture and Rural Development Departments construct and rehabilitate small irrigation systems, but their shares are considerably smaller than that of the ID. The Agricultural Department utilizes farmer financing through credit, in contrast to public financing through the ID. The Rural Development Department provides emergency rehabilitation assistance to small systems. For both AD and RD schemes, OM&M responsibility remains with the users; in contrast, ID requires communities to transfer ownership of their systems to the ID and they assume responsibility for OM&M. Recently, apparently, a moratorium on ID takeover has been declared.

THE INFLUENCE OF THE AID IRRIGATION PROGRAM ON INSTITUTIONAL CHANGE AND TECHNOLOGY TRANSFER

In retrospect, USAID's planning strategy at the ARD level had four identifiable goals. These were never formally stated, but are implicit

in the scopes of work and day-to-day procedures of the office. They were: improve planning and construction of systems so that reliable water supplies meeting farmers' objectives are delivered at farmers' fields; rationalize economic evaluation and utilize economic analysis as a planning tool; strengthen the support environment for irrigation farming, including improved application of water to farmers' fields; and institutionalize reforms so that they persist in the planning and construction and implementation process.

Origin and Evolutionary Path of USAID's Irrigation Portfolio

Historically, as USAID's portfolio developed, the set of problems which GOI and USAID agreed could be tackled through technical assistance expanded. Some of the details are summarized in the next section.

In its approach USAID, with little success, sought ways to shift a share of financing from hydraulic infrastructure to support of other components of irrigated agricultural production. This was difficult, partly because of USAID's preference for reimbursing government agency expenditures in contrast to supporting private investment and a lack of institutional candidates. Credit institutions are in place, but they do not view special programs of supervised credit with favor. The closest U.S. analog is the financing program of the Soil Conservation Service; the Indian Soil Conservation Services within the Agriculture Departments are candidates, but their expertise is largely in soil erosion control; the other candidates are the CADAs. The Team expects that USAID's efforts under its present irrigation portfolio will result in irrigation systems that work somewhat better, but there still remain some major deficiencies to optimal operation.

General Description and Objectives of the USAID/GOI Portfolio

The USAID portfolio of projects related to irrigation is directed principally at canal irrigation. For the most part it can be thought of as a single Canal Irrigation Program carried out through the GOI Ministry of Irrigation with the projects in each State as subsets of the program and the IM&T Project providing training and field studies broadly applicable to them all. The five State projects involve the construction of: 9 medium (2,000 to 10,000 ha) projects in Rajasthan; 9 medium projects in Maharashtra; 50 minor (100 to 2,000 ha) projects in Madhya Pradesh; 90 minor projects in Maharashtra; and 150 minor (averaging about 100 ha each) and numerous (up to 1,700) smaller (less than 100 ha) projects in Himachal Pradesh. Each new State project has evolved from the experience in developing (but limited experience in executing) its predecessors and thus each, although more complete in terms of the software package, is more complicated to execute. Because the minimum time for completion of medium irrigation subprojects is five years, and

AID's reluctance to approve projects for longer than five years duration as planned, few if any new medium irrigation subprojects will be completed, including chak development, by the AID Project Assistance Completion Dates (PACDs). For minor projects the plan is that many subprojects will be completed prior to PACDs.

Study and training activities are included with each of the construction projects to provide needed information to upgrade certain design criteria, test hypotheses and transfer technical information to Irrigation and Agriculture Department staff. In addition, the Irrigation Management and Training Project (IM&T) is designed to develop the Indian capacity to upgrade the general technical level of Irrigation and Agriculture Department staff and farmers in irrigation water management; plus do action on studies on operating systems to develop and test solutions aimed at improving canal irrigation systems performance.

Approximately three-quarters of the USAID/GOI irrigation portfolio is for concessionary financing of reservoir and canal construction and development below the outlet. From 30 to 35 percent of the remaining construction funding falls in the latter category. The remaining one-quarter is grant money to finance the study and training activities discussed above, most of which are directed below the outlet. The loan and grant monies combined make up a one-third billion dollar portfolio.

The USAID irrigation portfolio is presented as a step forward in promoting better canal irrigation systems performance through improved system planning, design and construction criteria plus training to stress improved water management with emphasis below the outlet and on farmer participation. The basic improvement targets specified include:

1. More careful analysis of and tighter design criteria for hydrological and primary water distribution aspects directed at the development of more economically rational projects;

2. More attention to seepage losses and usage of canal lining;

3. More flow measuring and cross-regulating structures;

4. Design for rotational water delivery with controlled flow rates, often in units of 30 lps (1 cfs) to be delivered for specified time intervals to the land area served, in accordance with pre-selected cropping programs, cropping intensities and realistic application efficiencies;

5. More accurate surveys of the command area with 0.2 to 0.3 m contours plotted on large layout maps where 1 cm represents10 to 20 ha level, using both social and physical criteria in designing the farm distribution layout;

6. Extending the water delivery network down to the 8, 5 or even 2 ha level, using both social and physical criteria in designing the farm distribution layout;

7. Providing demonstration chaks (actual farm units) in which land leveling and full irrigation development is provided along with special assistance with the selection of HYV seeds and proper fertilization;

8. Assisting in organizing farmer participation in the OM&M of their irrigation systems from the outlet up to the inlet as well as down to each farm unit;

9. Special studies to provide the additional knowledge on engineering, agronomic, socioeconomic and institutional matters needed to meet the above targets;

10. Action research projects that allow the testing of innovative technologies and management strategies in the context of live irrigation systems;

11. Developing in-country training capability and the output of trained personnel which are needed to meet the above targets;

12. Indirect impacts on the OM&M of State projects through improved systems, farmer participation and general training of Irrigation Department personnel;

13. Increased multidisciplinary, inter-agency and community participation in providing resources and in planning and OM&M; and

14. Increased attention to watershed protection within the command area and introduction of new crops, particularly in Hill areas.

State and National Policy Dialogue

USAID's program appears to have been appropriately focused toward specific program implementation policies and procedures where its projects provide pilot testing possibilities. USAID has neither ventured deeply, nor been invited by the GOI to venture deeply, into more State and national irrigation policies. It is unlikely that such dialogue would be feasible for USAID as long as its irrigation program continues to be an Irrigation Ministry program. This is evident because USAID only finances about one percent of the irrigation development programs the Ministry oversees.

Organizational Structures and Staff Development

In summary, the Team finds the following problems with the present institutional development and staffing efforts:

- The IDs are directly assuming many tasks which can only be, or could better be, implemented by other groups working in collaboration with them. The present set of institutions involved with the IDs is overly narrow;

- No organizational arrangements are being established to deal with the formation or strengthening of water user organizations;

- Many of the changes in the staffing patterns of the IDs involve merely moving Departmental staff into roles for which they are poorly equipped and for which they are unlikely to be rewarded by the standard agency procedures; and

- The staff development that is occurring is too narrowly oriented toward developing skills and capacities for work below the outlet level at the expense of overlooking critical needs above the outlets.

Procedures for System Design and Construction

In summary, the Team finds the following with the present stage of the physical development efforts:

- The physical performance to date appears to be addressing improvement targets (2), (3), (4), (5) and (6) from farm fields up through the minor canals in a reasonable fashion with some rather outstanding examples of success as well as some need for caution;

- It is too early to evaluate targets (7), (9), (10), (12), (13) and (14);

- The training (11) is moving and there is some evidence more careful attention must be given to who gets trained and the practicality of the course content;

- Our greatest concern is with improvement targets (1) and (2) in relation to main canals and (8) and USAID's own individual subproject appraisal, monitoring and evaluation, which we suggest is at least partly responsible for the bleak B/C outlook which we project. This is partly due to cost overruns and partly due to unrealistic expectations in terms of the true irrigation potential being created; and

- By USAID's heavy stress under its grant programs (software) on below-the-outlet problems and relative lack of attention elsewhere, overall irrigation system performance will probably remain disappointing. The heavy stress on below-the-outlet problems may be diverting needed attention from the equally serious need for designing for realistic levels of irrigation potential and

addressing (with significant resources) the critical OM&M problems. Without sufficient OM&M there is little hope of providing the consistently reliable and timely water deliveries needed below the outlet in order to induce farmers to operate, maintain and manage their joint delivery and farm irrigation application systems to achieve the hoped-for project production levels.

Operation, Maintenance and Management (OM&M)

Any impact which USAID's irrigation portfolio will have on OM&M will be indirect through improved systems and better trained personnel. Within USAID's assistance project time frames only some of the minor subprojects will reach the OM&M phase. The major part of the Water Management and Training Project is focused on OM&M. This should increase professional competence and bring more attention to bear on improved institutional arrangements to enhance OM&M. Suggestions for a way in which USAID might directly influence OM&M are made in Chapter VI.

Probable Productivity and Economic Impacts

Very little of USAID's irrigation portfolio has been constructed at this time. Therefore, assessing its probable impact on agricultural productivity and economic targets is difficult. However, the reasonableness of the estimates themselves can be assessed using recent field data on the benefit achievements of other similar projects along with updated cost estimates from USAID's experience to date. Because of lack of field data for Rajasthan, the Team's assessment is limited to Maharashtra.

From the point of view of overall benefits, the USAID improvement package would have to perform about 30 to 40 percent better than similar existing projects in order to reach benefit estimates, but that does not appear to be outside the feasible range. The practical effect of cost increases will be a reduction in the number of subprojects financed and a subsequent reduction in the target area to be irrigated. An additional problem is the utilization gap. Existing canal projects in India (and particularly in the Deccan Plain where AID projects are concentrated) irrigate only a part (30 to 45 percent) of the area their designs indicated they could irrigate. Considering the cost overruns and low utilization, the costs per irrigated hectare are likely to be more than three times those projected in the Project Paper. The USAID design package has some important elements in it not used in the surveys accessible to the Team and these surveys failed to measure "external" and off-farm benefits from irrigation. It is not unreasonable to assume that these two factors might make up the 30 to 40 percent difference. On the one hand, USAID projects appear to have a reasonable chance of reaching per hectare benefit estimates, but on the other, appear to have no chance of staying within cost estimates.

The Team feels that the economists did not properly adjust engineering estimates based on the best available data about what is actually happening in the field with existing projects. Such field realism would have resulted in more reasonable estimates of the area which the projects would likely irrigate, probable cost increases and the implied costs per hectare irrigated. This does not mean that the economists should have felt tied to the prevailing utilization rates and costs. Improvements proposed by USAID's package would permit some adjustment in those rates. Since the analysts were using internationally accepted methods and assumptions, they need not be faulted because those methods and assumptions are not working well in India. USAID's design process, which allows little time to investigate field realities with survey methods, and the short-term consultant style of project appraisal, is perhaps more to be questioned than those who conducted the engineering/economic analysis.

Cost benefit analysis is most useful as a comparison between investment alternatives. It should not be viewed solely as a project "hurdle," but rather to assist project designers and decision-makers in comparing investment alternatives. Investment alternatives include not only USAID's investment alternatives, but also the investment alternatives which face USAID's ultimate clients, the poor and small farmers. Current evidence suggests that small farmers in India have better alternative investments which they could and probably would make if they had $1,000, for example. In the Deccan Plain where USAID's projects are concentrated, one of these alternative investments could be a dug well if within the hydrological limitations of the aquifer (see Annex II).

In summary, from our review the projects appear to meet the 12 percent projected ERR standard as required by the USAID project criteria. However, actual field performance could be improved by using a different design process. The improved methods would involve added use of field data from existing systems to arrive at more realistic estimates of benefits, costs, completion schedules and utilization rates. This is a question of improving a process, not of meeting a prescribed standard.

Rural Equity and Employment

The project papers outline equity objectives at two levels: to increase irrigation on small farms; and to increase the incomes of the small farmers. One could add a third level: closing the relative gap between the rich and poor.

The target for increasing incomes of the small farmers to the Maharashtra Medium Irrigation Project is to increase it by 2.5-fold. Estimates from 800 farm surveys in Maharashtra suggest that small and marginal farmers increased their income through irrigation by 1.12 times. If the USAID package of design procedures and technical assistance worked as planned, it is not unreasonable to expect USAID projects to reach their target of a 2.5-fold increase in small farm incomes.

The last measure of equity is the relative income position of the rich and poor, or between large and small farmers. While small farm incomes are likely to reach USAID targets, the gap between rich and poor will probably widen as a result of irrigation in USAID-funded commands as it did in the ID projects included in the survey cited above. The more important problem from the equity point of view is that the poorest rural families are not small farmers, but rather the landless. The connection between the landless and irrigation is more fully discussed in the background paper for Chapter IV presented in Appendix E.

Irrigation Department Linkages With Other Institutions

Through the USAID irrigation projects the Ministry of Irrigation and State IDs are linking with other important institutions. However, especially in the case of the IDs, the set of institutions presently being involved is overly narrow. Important groups are missing from the potential network; in particular, technical and socioeconomic researchers, management specialists and resource groups experienced in farmer organizing. Moreover, the mode of interaction to be promoted needs to be one of networking rather than coordination of others by the IDs or a mere subcontracting of jobs to be done.

USAID's Relationship With Other Donors

The principal donors with which USAID has some fairly close dialogue about irrigation development are the World Bank and the Ford Foundation. However, at present the dialogue is more or less on an ad hoc professional and personal level rather than formally in joint projects. This could well be the most desirable mode.

One of the Team's final debriefing activities was a joint session with the top India office administrators and professionals from all three donors. To the Team's surprise, all three (rather independently) have reached about the same conclusion as to the most promising areas and activities for donor intervention in the Indian irrigation scene.

Conjunctive Use and Groundwater Development

The two Maharashtra and the Madhya Pradesh projects include the development of credit packages for wells, training courses on conjunctive development of groundwater and water balance studies and conjunctive use demonstrations. The Team thinks that these activities will have little impact on conjunctive use and groundwater development, at least in the near term. In Chapter VI possible ways in which USAID's irrigation program could be reoriented to capture some of the very considerable benefits which the earlier groundwater program achieved (with realized ERR of about 35 percent) are suggested.

Extensive and Intensive System Design

There are many different ways to use the terms extensive and intensive with reference to canal irrigation systems. This topic is discussed in considerable detail in Appendix C. USAID's current projects will have some impact on increasing the project intensity of systems through improved design criteria, but this will only eliminate the design gap part of the utilization problem at best.

Extending the cultivable command area without extending the actual irrigated area is directly related to the high cost of systems per actual irrigated area, and hence a major part of the B/C problem. In Chapter V specific ways are outlined in which the subprojects not yet commenced (close to 90 percent of the portfolio) could be redesigned to reduce their costs through more intensive designs.

CONSTRAINTS AND ASSUMPTIONS GOVERNING ALTERNATIVE FUTURES

Policies on Bilateral Assistance

Among the most important apparent GOI positions relating to bilateral assistance is holding a low profile of U.S. expatriate presence in India and the parallel relative lack of interest in serious general irrigation policy dialogue. The issue of the limited possibilities for long-term expatriate technical assistance is discussed below.

Groundwater Development Policy

For the most part, in accordance with GOI policy, groundwater has been developed in the private sector. The fluidity of groundwater policy, rather than being a constraint on USAID's future involvement in irrigation, presents important opportunities for policy dialogue. This opens opportunities for USAID technology transfer and institutional development in an emerging and perhaps more flexible institutional environment. Such dialogue is much more difficult in canal irrigation because of the very large momentum and sensitivity of GOI policy there.

Extensive and Protective Irrigation Policy

In many cases GOI policies appear to emphasize "protective" or "extensive" canal irrigation projects that constrain the productivity and equity impact of surface irrigation systems (as discussed earlier). This suggests that when "extensive" canal irrigation projects are analyzed using USAID economic criteria the number of qualifying subprojects will be so low that large USAID construction projects may not be viable options in the future.

Policy on Center and State USAID Relations

GOI policies on Center and State relationships govern USAID's future in irrigation, but they are not entirely clear at present. The Team suggests that they will only emerge as specific project possibilities are explored and USAID approaches to institutional mechanisms are developed.

USAID Budgetary Levels

USAID budgetary levels should not present any serious constraints on future irrigation alternatives if overall levels to India are more or less maintained at current levels, but the share of irrigation might be reduced given the project possibilities the Team currently envisions; however, as project possibilities mature the perspective could easily change.

Possible Long- and Short-Term Technical Assistance

The USAID alternatives in this area are limited and seem to point in the direction of the development of a rather unique (for AID) approach to project development, implementation and evaluation. That is the intensive use of local hire or consultant professionals. This is possible because India has a large number of trained professionals and world class and competent institutions. This is a less interventionist and more mature approach, but perhaps it will be a slower one. With the right mix of Indian nationals and expatriates it could be faster. For such an approach there needs to be longer term continuity with both AID direct hire and world class institutions and individuals from the U.S. A program approach could reduce the day-to-day burdens of project implementation and monitoring and open opportunities for a better planned and more orderly technical dialogue role for direct hire personnel. Provision of expatriate technical assistance "in kind" rather than through host-country procurement would reduce problems and improve relationships with GOI.

USAID Policies and Priorities

The policies and priorities for USAID's India program center on poverty and population. From the point of view of irrigation and poverty, most of India may be roughly divided into four agro-hydrological regions: the developed North, East INdia, the Deccan and the South. India's severe poverty is concentrated in the East. A large share of the untapped irrigation potential, particularly groundwater, is also in the East. These considerations argue for USAID involvement in irrigation in that area. However, the hydrological conditions, level of precipitation, intensive flooding, large rivers and the flat terrain are quite different than in the area where USAID now has considerable experience; there are

political and institutional differences also. USAID needs to understand these conditions more fully before taking a decision to expand its irrigation activities into this area.

Regarding ongoing programs, to achieve a set of effective operating medium irrigation subprojects in one or more States is an important goal. Considerations include how well improved appraisal, monitoring and evaluation can make these subprojects more effective and USAID's interest in a longer-term involvement through an OM&M phase. The future effectiveness of the training program (IT&M Project) will depend upon what structural and procedural arrangements, e.g., defining multi-agency responsibility, statu' of a multidisciplinary OM&M cadre, etc., the GOI and the States will put in place so that training benefits may indeed be captured.

AID Commitment to Long-Term Involvement

Working in a new mode in India dependent on greater involvement of local institutional partners would require much longer lead times in project development and imp ementation. A long-term USAID approach based on three phases is suggested:

- Examination of existing field experience and analyses of apparently viable irrigation development "models" in one or more of three agroclimatic regimes (Deccan, East and South);
- Development and implementation of specific "pilot" or demonstration projects in a single State for each "regime" to test these alternative models; and
- An attempt to use USAID funds as core or complementary funds to replicate the model, with larger contributions from other donors in other States inside the relevant regimes.

USAID assistance in this mode would be seen as a gradually widening circle of impacts based on field tested and proven irrigation "development models" appropriate for the major agro-hydrological regimes in India.

USAID Project Design Process

In discussions with USAID technical professionals it became apparent that there is a need to examine the conventional Agency approach to developing projects. Some think that the Agency structure and project mentality also create severe constraints in evolving good irrigation management (IM) projects and building those discrete projects into a workable strategy, partly because they do not allow the flexibility required.

There are several major constraints in the current project design process. The project development time frame is very short, but what seems to be needed is a series of useful studies and other activities to carefully prepare the environment for the new innovations (projects which fit into a program). The project agreements reviewed do not contain sufficient detail to provide guidance or controls for assuring that India lives up to the agreements made. Moreover, it appears that AID/W is moving further toward the software dimensions of IM such as training, institution building, action research and special studies and community organizations. However, AID/W is giving insufficient attention to the need for more staff support for the successful implementation of these components.

SOCIO-TECHNICAL OPTIONS FOR FUTURE USAID ACTIVITIES IN THE CURRENT IRRIGATION SECTOR PROGRAM

The current USAID irrigation program is faced with three major issue areas: disappointing B/C realities stemming from higher than expected construction costs for systems which will serve less irrigated area than projected; chak size questions which relate to manageability and maintainability by the IDs above the outlet and by farmers below it; and a whole set of institutional questions resulting from requiring IDs to take on new roles and cooperate in new working relationships with other institutions, as well as their farmer clients.

The focus of the software aspects of the Mission's portfolio is below the chak outlet, but this is only part of the irrigation management (IM) picture. While the Team does not feel below-the-outlet issues are of a lesser importance, we do recommend giving more attention to the issues relative to the analysis of benefits and costs and to designing and managing systems to deliver equitable, reliable and timely flows and discharges throughout the entire system.

Irrigation Technology Options

The current program in one way or another contains most any practical technical option the Team can think of. Thus, the most important consideration is selecting the set of technical options which the Mission and the State IDs should concentrate on. The Team recommends focusing on the following:

1. For the new individual medium and minor subprojects (of each State project), concentrate on assessing and monitoring throughout the planning, design, construction and commissioning stages;

2. Conduct water budget studies and concentrate on the reliability and timeliness of water deliveries and economic realities of the entire system (with limited analysis below the outlet) when

appraising exising systems for rehabilitaion and/or management improvements. Furthermore, appraisals carried out for the purpose of gathering information (not training) should be done as rapidly as possible and should offer recommendations which are practical within the realm of socioeconomic potentialities;

3. Select technologies and designs (including pipe as well as lined or unlined channels) for the main distribution networks which are practical for the ID to operate, manage and maintain. The most important challenge for the IDs is to provide visible, equitable and reliable water deliveries at public outlets serving 20 to 100 ha chaks. By reliable, we mean consistent deliveries made in a timely nature to meet aggregate crop water requirements within each chak in view of the real-time crop, soil water storage and weather conditions;

4. Provide support for expert technical assistance (addressing both physical and social considerations) for laying out, obtaining rights-of-way and designing watercourses within the chaks below the public outlets;

5. Take a more pragmatic approach to the whole area of conjunctive use including both wells and return surface flows;

6. Direct more software resources and attention to managing the main system down to the public outlet. What the Team seeks is a balanced program of software for all physical components of the system from farmers' fields to the reservoir and institutional components from the farmers and their organizations up through the irrigation agencies; and

7. Pinpoint most training directly at the task-oriented level (as opposed to the general educational level) to carry out the above.

Institutional and Farmer Organization Options

Implementing Institutional Development Activities

The major problems are related to IDs assuming too many of the institutional development activities themselves and failing to develop a network of resource organizations to work with them. This problem is exacerbated by the fact that there are few USAID staff members familiar with this dimension of irrigation development. We recommend the following four actions to improve these problems:

- First of all, USAID should communicate clearly to the ID with which it is working that the scope of objectives included in the various projects cannot be achieved by the IDs acting alone, or with a small

group of other government agencies. A larger network of resource organizations, some not traditionally involved with the activities of the IDs, must be engaged in the effort.

- Then USAID should identify and arrange for some key Indian partners to jointly work on the institutional development components of the irrigation projects. Funds to support this partnership effort could be available under the action research component of the present IM&T Project. If these are inadequate, USAID will need to consider a new project as a funding mechanism for this activity.

- Third, a representative, or representatives, of these key partner institutions should be included in whatever is the important policy unit for the State concerned.

- Finally, a plan needs to be developed for establishing a network of resource organizations in each of the five States with USAID projects.

Water User Organizations and Community Management

While all the USAID projects call for attention to water user organizations, little has been accomplished on this matter. This may be in part because USAID has accepted the idea that IDs will be responsible for user organizations. However, there have not been any special cells or other organizational units established to implement this part of the program except for a committee that has been formed in Madhya Pradesh. The only action has been to suggest that farmer organizing will be the function of the field staff of the ID, or perhaps the Agricultural Extension staff.

Four actions are suggested for moving ahead with water user groups:

- First of all, USAID needs to demonstrate the importance it places on farmer organizations. It should make it clear to the IDs involved that the strategy of organizing water user groups as identified in the various projects is not a strategy that can be directly implemented by them, although IDs need to be closely involved. The IDs must act as partners to actively implement the organizing activities.

- Then at least one of the key Indian partners should be experienced with matters of farmer organization, although they may not have specific experience with organizing farmers for irrigation development purposes.

- Third, USAID should set the target of establishing one (or perhaps two) "world-class" pilot efforts with organizing water user groups on public canal irrigation projects in India.

- Finally, in developing a strategy for forming water user groups, consideration should be given to extracting lessons from and using the "catalyst" model that has been found to work in the Philippines, Sri Lanka and Indonesia. In considering the applicability of the catalyst or any other approach, as a first step we recommend learning much more about the past experiences of the ID in organizing farmers in that particular State and project size groups, as well as the range of irrigation groups that may already exist there.

Productivity, Equity and Economic Options

This section outlines a number of specific project design and administration changes. These are changes which our preliminary economic evaluation suggests might be undertaken to improve the productivity, equity and profitability of the yet-to-be-designed subprojects. Although they obviously involve both engineering and institutional suggestions, they are presented from an economist's point of view. The engineering and institutional points of view of many of these same issues were addressed earlier. Without additional data it is difficult to estimate the relative potential of the 11 suggested changes which follow or to identify others. The importance of each suggested change and recommendations for additional ones will only become clearer when additional carefully-collected field data is available. These suggestions should be regarded as flexible, with additions, changes or deletions made as new data and insights become available. Such data could be gathered as part of in-depth subproject appraisals.

1. Rather than overextending canals for questionable political reasons, the cost could be reduced by simply reducing the length of the canal systems without really reducing the area actually irrigated.

2. Reservoirs may in some cases be reduced in size (i.e., planned at higher rainfall probabilities) and thereby reduce the cost and increase the reliability of irrigation, without reducing the areas actually irrigated by much, even in high runoff years.

3. The extra costs invested in extra canals which will seldom be used could be avoided by correctly accounting for seepage which would lead to not constructing the excess canals.

4. Seepage losses can be reduced significantly by selectively lining the canals in high seepage loss reaches. Losses can be almost eliminated by using fully lined canal systems or closed pipe systems.

5. Return flow drainage water can be pumped back to the main channels or reused in downstream irrigation developments.

6. The number of wells inside and below the command can be increased to capture and reuse the seepage from the canals.

7. Improvements, including water controls and measuring structures, and procedures which can significantly reduce water waste in headreaches and force this water further down the system should be made. This would increase the area actually irrigated, and while not reducing the costs, would increase the benefits.

8. The wastage and lack of demand could be remedied and project benefits increased by eliminating restrictions on crop patterns and procedures and by changing the water delivery to depend more on farmer organizations and rotational water supply systems. In those cases where crop restrictions have limited the growing of high value labor-intensive crops the increased socioeconomic benefits could be very substantial.

9. In many cases canal-reservoir irrigation projects may be helped in meeting economic and equity criteria by designing and administering them to reduce kharif deliveries and/or start or increase summer deliveries of water.

10. In many cases medium and minor irrigation project benefits could be as much as doubled by designing and administering them to utilize irrigation return flows. This can be accomplished through better organized well development and other pump-back or return flow schemes in the command or slightly below it.

11. In many cases total irrigation costs may be reduced and benefits increased by incorporating improved application techniques such as precision surface leveling, sprinkle or trickle irrigation in the project design.

RECOMMENDATIONS FOR FUTURE PROGRAM

Chapter VI discusses options for future USAID activities in the irrigation sector. In the first section suggestions are made regarding program design and program management and implementation. In the second section several options for future program actions in both surface water and groundwater development are identified. The third section makes suggestions regarding the ongoing program.

Program and Project Development

There is a serious need for longer lead times and more background studies and preparation for future projects, as discused earlier. Both GOI and AID/W policies apparently will preclude any significant increase in direct hire staff. Moreover, there are significant disadvantages in always having to work through short-term expatriate planning teams.

An alternative is to develop long-term relationships with key Indian institutions that have the capacity to conduct background research, explore possible program lines and otherwise participate with USAID in the conceptualization and initial planning of new program areas, and in the further implementation of current projects, particularly IM&T. Such national institutions could play a role in the implementation stage of projects, often working with and through State-level institutions for various project activities. This arrangement with key Indian institutions would allow a logical point of contact between any U.S. expertise involved in the project planning and development stage in addition to the linkage that such consultants would have with AID staff.

Geographic Concentration

The present portfolio of irrigation projects already involves USAID with six different State governments as well as the Center. Geographic concentration would not only have a positive impact on practical matters of travel and logistics, but allow Mission staff and staff from the key Indian institutions working with USAID to become familiar with and known to the important irrigation policy makers and implementors in those States. Therefore, in planning future irrigation activities such as those discussed below, USAID should first consider the option of implementing these activities in one or more of these six States. However, given the extreme poverty and good irrigation potential in Eastern India, as discussed in Chapter IV, USAID should cautiously look at possibilities in that region, particularly as they relate to groundwater development.

Specific Program/Project Molds

The Team proposes looking at a few new program/project areas or models. These are:

1. Direct assistance with canal irrigation system operation, management and maintenance. This would fit nicely as a project in the current USAID irrigation program;

2. Direct assistance to local sector irrigation which involves the rather large set of small irrigation projects accounting for approximately 5 percent of all irrigation in India, but which generally falls outside of the jurisdiction of the State IDs;

3. Development and testing of a model of improved system management through rehabilitation and disaggregation of a major canal reservoir irrigation system, plus ongoing management assistance; and

4. Commercial groundwater development with a focus not only on well development, but also on technical assistance with pumpsets, improved application systems and marketing.

Ongoing Program

None of the subprojects under the two medium irrigation projects will likely be fully completed including chak development by the Project Assistance Completion Date. Considering that USAID will have gained a great deal of locale-specific expertise with these projects, they could be interesting candidates for incorporating the Irrigation System Management Model referred to in the previous section. USAID should consider continuing support for their completion so that they could be effectively phased into the OM&M stage. For the in-service and University training and the Hill Area Development programs, the Team recommends that decisions be left open pending appropriate evaluations.

IRRIGATION SECTOR STRATEGY REVIEW
USAID/INDIA

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APPENDICES

VOLUME I

Each Appendix section was developed by an individual author as a background piece for this report. Each represents the efforts and opinions of its author, not necessarily the general opinion of the Team, and is in the form in which it was received (without specific editing and/or retyping).

Volumes I and II are available on request at $10.00 each from the Water Management Synthesis II Project, Agricultural and Irrigation Engineering Department, UMC 41, Utah State University, Logan, Utah 84322.

A. BACKGROUND PIECES FOR THE ANALYSIS OF IRRIGATION INSTITUTIONS IN RELATION TO PROJECT IMPLEMENTATION

1. Descriptive Analysis of Irrigation Institutions in Madhya Pradesh
   by Elisabeth H. Sims

   - Role of the Central Government
   - Role of State Agencies
   - Planning, Design and Operation of Systems
   - Supporting Functions

2. Central Government Institutions
   by Dean F. Peterson

   - Key Institutions
   - Resources
   - Some Important Issues

B. THE USAID/INDIA IRRIGATION PORTFOLIO
   by Dean F. Peterson

   - Origin and Evolutionary Path of the Irrigation Program
   - Current Program Objectives and Description
   - Impacts on Institutions and Technologies

C. BACKGROUND ON SOCIOECONOMIC ANALYSIS OF IRRIGATION IN INDIA AND PROBABLE IMPACTS OF THE USAID/INDIA IRRIGATION PORTFOLIO
   by Samuel R. Daines

   - Benefit Cost Analyses
   - Conjunctive Use and Groundwater
   - Rural Equity and Employment
   - Extensive and Intensive System Design

APPENDICES (Continued)

VOLUME II

D. IRRIGATION POLICY IN INDIA - HISTORICAL TRENDS AND POLICY ISSUES WITH EMPHASIS ON THE DECCAN STATES
by Samuel R. Daines

- Surface and Groundwater Policy: An Overview
- Historical Trends in Surface Irrigation Policy
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E. ANALYSIS OF SELECTED PRODUCTIVITY, EQUITY AND ECONOMIC ISSUES FOR IRRIGATION IN INDIA
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- Productivity
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F. RECURRENT COST STUDY OF OPERATION AND MAINTENANCE OF IRRIGATION SYSTEMS IN MAHARASHTRA
by Jagannathrao R. Pawar

- Development of Irrigation Resource in Maharashtra
- Arrangements for Operation and Maintenance of Irrigation Systems
- System Level Study of Operation and Maintenance of Irrigation Systems

BACKGROUND DATA

A set of background data entitled "A Statistical Profile of Agriculture, Nutrition and Development Trends in India: A Case Study of Maharashtra State" was developed for the report. This set of data is available for $25.00 from the Water Management Synthesis II Project, Agricultural and Irrigation Engineering Department, UMC 41, Utah State University, Logan, Utah 84322.

Part I: Summary Profiles at the State Level

Part II: Detailed Statistical Profiles at the District Level

Part III: Selected Statistics on the Food System of Maharashtra from Studies Collected with the Assistance of J.R. Pawar and R. Balasanduram

CHAPTER I

OVERVIEW OF THE INDIAN FOOD AND AGRICULTURE SITUATION AND THE ROLE OF IRRIGATION

This chapter provides an overview of the Indian food and agriculture situation with emphasis on the contribution of irrigation. The focus of this short summary will be on "food" as well as agriculture, as the perspective of nutrition is a vital one in the Indian context.

Overview of the Indian Food Situation: Nutritional Supply and Demand

Supply of Foodgrains

Table 1 outlines the availability of foodgrains per capita during the last century. The table suggests dividing the last hundred years into three periods. The first period, from the 1890s to the 1920s, was a high availability period with foodgrain availability nearly 700 grams/capita/day. The second period was one of declining availability resulting from steady, absolute production in the face of rapidly expanding population. During this period of some 30 years per capita availability dropped from nearly 700 grams/day before 1920 to a low of 385 in 1952. The third phase since 1953 has seen an erratic but slowly growing trend in per capita foodgrain availabilities in the face of continuing rapid population growth.

The first part of the growth phase from 1951-1968 appears to have been caused by an expansion in the area cultivated associated with increases in surface irrigation. From 1968 forward the increases apparently were caused by the yield increases generally from the "Green Revolution," which was supported mostly by the expansion in groundwater-based irrigation.

Many thought that the growth trend in output of foodgrains had stagnated in the late 1970s. Analysis of detailed production data appears now to question the stagnation hypothesis,[1] and recent studies now suggest that the growth trend since 1953 has continued to date around a reasonably continuous trend. If this position is correct, as we think it is, it implies that the "Green Revolution" did not have any impact on the rate of foodgrains growth. It simply allowed the growth rate to continue based on increased yields after the area for expanding cultivation ran out in the sixties.

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[1] T.N. Srinivasan, "Trends in Agriculture in India, 1949-50--1977-78," Economic and Political Weekly, August 1979, p. 1283.

TABLE 1

FOODGRAINS AVAILABILITY PER CAPITA IN INDIA

Year	Grams/Capita/Day
1893-1896	731
1896-1906	698
1906-1916	681
1916-1926	670
1926-1936	574
1936-1946	496
1951-1952	390
1953-1956	438
1956-1966	451
1966-1976	438
1976-1981	450
1981-1984	511*

*Provisional estimate.

Sources: 1893-1946 from Bhatia, Famines in India, New Delhi, 1974; 1951-1981 from Directorate of Economics and Statistics, Bulletin on Food Statistics, New Delhi, 1982, p. 141.

Nutritional Supply and Demand for All Food Products

There is a tendency in India to equate "food" with "foodgrains." Though foodgrains provide a large part of the calories in the Indian diet, the other food items must be included in an overview of the nutritional supply and demand picture. Table 2 presents an overview of "nutritional" supply and demand based on production in 1980-81 and the nutritional requirements of a "least cost" average diet for the Indian population in that year.

Table 2 shows that there is a discontinuity between the pattern of foods being produced and the pattern that would be demanded by the least cost adequate diet. From this table India appears to be already producing more foodgrains than would be required by a least cost average diet to feed its population. Fruits and vegetables constitute about 55 percent of the nutritional deficit, with milk at about 30 percent.

Perhaps the most important implication of Table 2 is that even if all food were equally distributed, India would need to expand production

TABLE 2

FOOD PRODUCTION AND FOOD REQUIREMENTS IN INDIA
(FOOD BALANCE 1980-81 IN MILLIONS OF METRIC TONS)

Food Items	Production 1980-81		Actual Nutritional Requirement 1980-81		Surplus or Deficit- Deficit	
	(mmt)	(%)	(mmt)	(%)	(mmt)	(%)
Foodgrains	129.9	59.2	123.9	42.7	+ 6.0	0.0
Other Foods	89.5	40.8	166.5	57.4	-77.0	100.0
Other Foods						
Fruits & Veg.	37.9	17.2	80.1	27.6	-42.2	54.8
Milk	30.2	13.8	53.0	18.3	-22.8	29.6
Fats & Oils	2.2	1.0	11.0	3.8	- 8.8	11.4
Meats & Fish	3.8*	1.7	10.8	3.7	- 5.5	7.0
Sugar	15.4	7.0	11.6	4.0	+ 3.8	0.0

*Provisional estimate.

Sources: Least cost diet pattern per capita, from Gopalan, "Some Aspects of Nutrition in India." In: Population in India's Development, New Delhi, 1976, pp. 101-102. Production 1980-81 from Directorate of Economics and Statistics, Bulletin on Food Statistics 1981-81, New Delhi, 1982. Population 1980-81 from Census of Population 1981, New Delhi, 1983.

by approximately one-third to feed its population a "least cost" adequate diet. When the realities of unequal distribution are accounted for, food production would probably have to increase by perhaps half to provide a least-cost minimum diet to the existing population.

All of the increased production to satisfy the nutritional demand of the average least-cost diet are in non-foodgrains categories, but averages are often deceptive in nutritional matters. Since foodgrains are not equally distributed, there are large populations in India who have not yet reached even the least-cost diet levels of foodgrain consumption. Increased production of foodgrains would be required to lift these populations to the least cost diet levels, and still more to supply foodgrains to the additional population that is added yearly. Moreover, foodgrains generally supply a larger number of calories per unit of weight than do other food items, and therefore their relative importance from the point of view of energy (which is the most pressing nutritional deficit in India) is understated by the weight units used in Table 2.

The implication of Table 2 is not that foodgrain production would not need to increase over time to supply an adequate diet, such an increase would be necessary and appears to be happening. The implication of the table is rather that the major nutritional deficits in the current production pattern are in non-foodgrain categories dominated by fruits, vegetables and milk.

Summary of Nutritional Supply and Demand

India does not appear from the data we have seen to be nearing nutritional self-sufficiency. It appears that food production would need to increase by perhaps 50 percent in order to feed the population a least-cost adequate diet. The major deficits are in fruits, vegetables and milk, not in foodgrains, though increased foodgrain production would also be necessary. Foodgrain production appears to have expanded slightly faster than population in a somewhat erratic trend since 1953 with no noticeable change at the time of the Green (or perhaps more accurately "grain") Revolution.

Overview of the Indian Agricultural Situation, Market Supply and Demand

In India subsistence and market driven agricultural production exist side by side in most rural areas. The transition to a predominantly market agricultural economy has not been rapid. Income per capita is rising, albiet slowly in towns and cities, and even in rural areas. This accumulating income exerts pressure on production through market mechanisms. The most obvious of these pressures comes from the large urban areas. Food consumption by income levels for Calcutta, presented in Table 3, provide a good example of the directions of this market demand pressure.

Table 3 indicates that market forces are pulling production in roughly the same directions that nutritional demand would dictate. The market pull on foodgrains appears to stagnate at relatively low levels of income, just slightly above the average Indian income level of 1970. This implies that those Indians below that level will continue to purchase additional foodgrains as their incomes approach the 1970 average. Since average income per capita is rising at about 1.3 percent per year, the population which has reached the foodgrain demand stagnation level is increasing each year by about that same margin. Substantial populations still lie below this foodgrain demand stagnation level of about US $200 income per capita in 1982. For these families increases in income will still be spent partly for additional foodgrains. To this incremental demand for foodgrains from increased income must be added the incremental demand which arises from added population.

Table 3 shows that the two commodities (foodgrains and sugar) which Gopalan's discussion of least-cost indicated are already over-produced on the average also have the lowest income elasticity of demand.

TABLE 3

PER CAPITA CONSUMPTION OF FOOD PRODUCTS BY
FOOD EXPENDITURE LEVEL
CALCUTTA 1970
Expenditure Level (Rupees/Month/Capita)

Food Item	Exp. Level 1 >20 Rs/mo	Level 2 20-40	Level 3 40-60	Level 4 60-100	Level 5 100+	Ratio of Level 3 to 1
	grams/day	gr/day	gr/day	gr/day	gr/day	(3)/(1)
Foodgrains	328	368	392	398	392	1.2
Milk & Eggs	20	39	87	133	238	4.4
Fruits	6	12	28	46	60	4.7
Vegetables	100	158	206	247	276	2.1
Oils	10	15	21	27	35	2.1
Meat & Fish	19	25	38	45	69	2.0
Sugar	21	25	30	36	43	1.4

Source: Computed by S. Daines based on data from A Study of Food Habits in Calcutta, U.S. Agency for International Development, New Delhi, 1972, 166 p.

Market demand pressure appears to be strongest in milk and fruit categories with strong demand for vegetables (including potatoes), oils and meat/fish. Purchases in the milk/fruits groups increase by more than fourfold as incomes increase from the lowest group to the slightly above average income group in 1970.

It would appear that the long-term trend driven by internal markets would be to a gradual shift in product composition from 60 percent grains and 40 percent other products to the reverse, with 40 percent grains and 60 percent other products.

External markets could have some impact on the shift in product composition of the agricultural sector. The basic factor endowment pattern of India, scarce land and capital and abundant labor, make India a poor competitor in international grain, milk and meat markets. These same factor endowments linked with India's seasonal advantages could place India in a good competitive position in many fruit and vegetable products. However, poor marketing/processing technology and marketing infrastructure appear to be major constraints on rapid export expansion of these products.

The Role of Irrigation

This section is the bridge between Chappter I on food and agriculture and the other five chapters which deal with irrigation. Its purpose is to assess the contribution and role of irrigation in food and agriculture up to the present, and then to suggest how that role will change and emerge as the transition to commercial agriculture deepens.

Role of Surface and Groundwater Irrigation 1950-1980

Ashoka Mody[2] provides a concise review of the contribution of irrigation to recent agricultural growth:

> To understand . . . the reasons for growth in the fifties, it is necessary to go beyond the proximate sources of growth. It is well known that water is critical for agricultural production. . . . In the fifties, increase in area under irrigation provided the main impetus for growth. More than three-quarters of the increase in area under irrigation was accounted for by government canals and tanks. Canals and tanks provide, in general, extensive irrigation, i.e., irrigation of the type that implies "light irrigated crops" and wide distribution of water." As a consequence, agricultural growth during the fifties was of an extensive nature.
>
> In the 1960's . . . irrigation in general supported the more intensive application of modern inputs. It may be noted, in this connection, that the use of fertilisers and HYV seeds required controlled and intensive irrigation, i.e., a given volume of water concentrated in a relatively narrow area. These requirements induced the growth of tubewell irrigation in the sixties. During that decade, about three-quarters of the increase in area under irrigation was due to an increase in the area under tubewell irrigation. Extensive irrigation does not permit large cropping pattern changes, whereas intensive irrigation does. We therefore do find that the extent of cropping pattern changes in the sixties was much more than in the fifties.

Mody's allocation of the contribution of the role of irrigation in agricultural growth gives first place to irrigation in both the fifties and the sixties, yet the kind of irrigation which he finds was associated or responsible for the growth in the two periods changes. In the fifties the growth came not from yields or crop mix changes, but from an increase

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[2]Ashoka Mody, "Growth, Distribution and the Evolution of Agricultural Markets," Economic and Political Weekly, January 2-9, 1982, pp. 25-38.

in the gross irrigated area in cereals made possible by the construction of "extensive" canal irrigation schemes. Since the sixties both yield increases and crop mix changes accelerated growth and were made possible by an increase in groundwater irrigation. Mody assigns three-fourths of the impact in the fifties to canal schemes and one-fourth to groundwater, while in the sixties he assigns three-fourths to groundwater and one-fourth to canal schemes.

Yield increases in foodgrains were found by Rogers[3] to be closely associated with irrigation:

> Using a variety of data sources from 1901 to 1972 (Rogers) correlated the average foodgrain yield with some of the other variables . . . As expected, the foodgrain yield correlates well with net irrigated area, expenditure on irrigation, canal irrigation, tanks and tubewells.

Role of Surface and Groundwater Irrigation 1970-1985

Mody's estimate of three-fourths groundwater share in irrigation contribution to agricultural growth in the sixties needs to be updated to account for the 15 years since 1970. Official estimates in the Sixth Plan indicate that 34.6 million hectares of surface irrigation "potential" had been created by 1980 and 22 million hectares were being irrigated by groundwater.[4]

It is well known that only a part of the surface "potential" is actually realized or "utilized." Estimates of "utilization" vary widely and are examined in detail in Appendix D to this report. Given the data we have reviewed, it appears unlikely that more than about half of the 34.6 million hectares of surface "potential" is actually irrigated in an average year. This would indicate that as of 1980 about 17.3 mha (44 percent) were irrigated from surface sources and 22 mha (56 percent) from groundwater.

To assess the relative contribution of surface and groundwater to agricultural production it is important to weight the area irrigated by the cropping pattern difference that is known to exist between groundwater and surface irrigation. Mody suggests that cropping pattern difference results from the "intensity" or reliability of groundwater. A major attraction of groundwater is that unlike canal water, it is under

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[3] Peter Rogers, Irrigation and Economic Development: Some Lessons from India, Division of Applied Sciences, Harvard University, Cambridge, 1983, p. 13.

[4] Government of India, Sixth Five-Year Plan 1980-1985, Planning Commission, New Delhi, p. 148.

the farmer's control and may be used when needed for timely irrigations. This reliability is often prerequisite before farmers are willing to supply the other inputs needed for high value production and for shifting to higher value crops such as those where India now has nutritional deficits.

There is general agreement that groundwater irrigation supports a higher value mix of crops than surface irrigation, but few studies have actually quantified the magnitude of that difference. V.M. Rao and M.G. Chandrakant use estimates from an Agricultural University study to derive an index of gross value of output per unit of land under tank, canal and well irrigation. Their rough index suggests that the gross value of production of well irrigation is about 1.8 times that of the average of canal and tank irrigation.[5] If Rao's index is used to obtain a weighted estimate of the share of irrigated production between surface and groundwater, we conclude that at the beginning of the eighties about 70 percent of irrigated production is from groundwater and 30 percent is from surface irrigation.

Future Possibilities for Surface and Groundwater Irrigation

The Sixth Plan estimates that the ultimate irrigation potential is 73.5 mha from surface sources and 40 mha from groundwater.[6] If the surface "potential" is deflated by a realistic expected "utilization" rate of 50 percent, there would be a total of about 37 million hectares of possible surface irrigation and about 40 million hectares of possible groundwater irrigation according to the Sixth Plan. Using the current actual exploitation figures derived above, the Sixth Plan estimates would imply an untapped potential of about 18 million hectares irrigated by groundwater and 20 million hectares irrigated by surface water.

Chambers, writing in 1984, provides a useful updating of these Plan estimates based on more recent information on groundwater:[7]

> Estimates of the usable renewable recharge of groundwater have been rising, and have more than doubled in the past 14 years . . . the groundwater estimates of the CGWB (Central Groundwater Board) give a utilisation of 10.0 m.ha.m. against a

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[5] V.M. Rao and M.G. Chandrakant, "Resources at the Margin: Tank Irrigation Programme in Karnataka," Economic and Political Weekly, June 30, 1984, p. A56.

[6] Sixth Plan op.cit., p. 148.

[7] Robert Chambers, "To the Hands of the Poor: Water, Trees and Land," paper for the Institute of Economic Growth, Silver Jubilee National Seminar Programme, Delhi, April 27-30, 1984, p. 10-11.

potential of 42.3 m.ha.m., or a utilisation of only 24 percent of the potential. As these figures are reconciled, the estimate of gross hectares irrigable can be expected to rise. One unreferenced source gives this as 72 million hectares, of which only a quarter (18 million hectares) is said to be utilised.

Whatever the final figures, there seems no room for doubt that the groundwater potential of India is much greater than earlier believed, and that it presents immense opportunities for millions of the rural poor. The spread of rural electrification and the increase in lift irrigation have been little short of spectacular during the past three decades. In one perspective this can be seen as a countryside scramble for a big frontier.

Groundwater has a significantly lower development cost, and supports a higher value of production per hectare compared to surface irrigation. Moreover, development investments are much more divisible. When these two economic factors are added to the emerging evidence on the size of untapped potential, re-examination of priorities would be useful. Rogers[8] concludes his recent paper with thoughts in this direction:

> Given the rate of return and the remaining potential for irrigation by various technologies, the possibility arises that, maybe, the planning goals should be changed from the existing concentration on surface to the groundwater developments, and an improvement of the existing surface water systems. Planning for efficient use of the existing . . . surface irrigation systems and expanding the groundwater to its full potential . . . looks like an attractive strategy. . . . This approach could significantly reduce the public expenditures on irrigation, perhaps by as much as 50 percent. The decision to change the strategy should not be taken lightly, however. The development inducing aspects of large surface projects needs to be carefully analyzed and assessed in relation to the narrower development impacts of private (or public) tubewell projects. The final choice between the strategies may well hinge on a view of what rural India should look like in the early parts of the next century rather than the short run production benefits obtainable by each of the strategies.
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> The paradox is that we must decide ex-ante if a particular investment choice is a good one or not without being able to predict in any coherent way how the economic development parameters to the cultural, social and economic environment are likely to change over the life of the project.

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[8] Rogers, op. cit., pp. 36-38.

At present all we can do is do the best and fullest social benefit-cost analysis and hope Hirschman's "hiding hand" will help the project muddle through to some satisfactory future.

Both nutritional and market demands in India are leading a slow transition from a subsistence grains based agriculture to a more diverse and commercial rural economy with a larger role for fruits, vegetables and milk products. More reliable irrigation based on private groundwater development appears to be supporting, if not leading, this transition. This raises important issues for public irrigation investment in the future which can only be resolved through public policy analysis inside a much improved framework of social benefit/cost analysis.

CHAPTER II

IRRIGATION INSTITUTIONS AT THE CENTER AND IN SELECTED STATES IN INDIA*

Introduction

Most discussions of the institutional arrangements for irrigation begin by noting that in India's federal system irrigation activities are the responsibility of the States. That is, of course, accurate and is the reason that this chapter summarizes important irrigation institutions in several States: Maharashtra, Madhya Pradesh and Himachal Pradesh. However, there are important irrigation factors at the Center or federal level which will be considered.

It is also important to recognize that there are significant and vital parts of irrigation that are outside the purview of the mainline Irrigation Departments and the Center's Ministry of Irrigation. The most obvious of these is the private irrigation sector, which is the primary sector in which groundwater supplies are developed and utilized. While the private sector is highly influenced by government policies on matters such as credit and rural electrification, it does enjoy considerable freedom in developing and managing water supplies. However, this freedom is sometimes curtailed in canal systems managed by the States.

Another, but less visible sector, is what can be called the "local irrigation sector." Usually it involves small gravity or lift systems which are under the control and management of local groups such as village or district panchayats, or sometimes independent water user groups. While autonomous with regard to Irrigation Departments, they may receive financial and technical assistance from other government agencies such as the Department of Agriculture or of Rural Development.

AID's irrigation projects must operate in these various institutional settings; each State setting has a common "Indian" institutional style, but simultaneously may exhibit variations reflecting historical and contemporary local conditions. Thus, the objective of this chapter is to provide a sense of both the "Indian" style of irrigation institutions and of the variations between States. While both the Center and selected States (in which AID had almost all of its irrigation program activities) will be discussed rather fully, the private and local sectors will also be considered.

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*This chapter draws heavily on previously drafted materials provided by Dean F. Peterson, Samuel R. Daines, Elisabeth H. Sims and E. Walter Coward, Jr., who dealt with the Center, Maharashtra, Madhya Pradesh and Himachal Pradesh, respectively. For the Center and for Madhya Pradesh this material is separately bound as Appendix A.

Irrigation Institutions at the Center

There are several institutions at the Center level which deal with irrigation. The functions of each are briefly discussed below.

Ministry of Irrigation

The size and role of a Center Ministry depends on whether or not it deals with a subject which is the responsibility of the States. Since this is the case with the Ministry of Irrigation, it largely plays a role of coordination. Thus, it is relatively small and not organized into separate departmental units. It is headed by a politically appointed Minister who is supported by a Secretary of Irrigation and his/her technical and administrative staff.

Even though irrigation development activities are implemented by State Irrigation Departments, a considerable portion of the resources for these projects comes from the Center. Thus, a primary function of the Ministry is to advise the Cabinet, the Legislature and the Planning Commission on the allocation of federal resources to the various States. Some allocations are made for State initiated projects for which assistance has been requested. However, the Ministry also takes initiative in identifying new policies and approaches to irrigation development and management. If approved, these initiatives often carry with them some level of Center resources to encourage State participation through partial subsidies or grants. The Center controls Plan funds, which are derived from certain taxes, such as income tax, dedicated to the Center and international loans and grants. About one-sixth of the Plan budget is allocated to irrigation. Also, under the administration of a Joint Secretary, the Ministry provides guidance regarding irrigation development support from foreign funding. At the State level agency budgets are divided into Plan and non-Plan categories, the latter coming from State revenues. Plan funds generally are used for the development of facilities, whereas non-Plan funds must cover operational and recurring costs and facilities for which Plan funds are not provided.

The Central Water Commission (CWC). The CWC is the technical wing of the Ministry. It is divided into four major divisions: (1) Water Resources; (2) Projects and Planning; (3) Floods; and (4) Design. Each of these divisions is headed by an individual with the equivalent rank of Joint Secretary. The Chairman of the CWC has the equivalent rank of Secretary. The CWC sets design and construction standards for all irrigation projects which are planned for commands exceeding 2,000 hectares (i.e., all medium and major projects). State projects for which financial assistance from the Center is requested are subjected to technical and cost reviews by the CWC and, if found satisfactory, certified to the Planning Commission as technically sound and qualified for financial support.

For externally-funded medium and major irrigation projects the CWC has set up special appraisal cells to review project proposals for

compliance with special criteria included in the loan agreements. These cells also inspect and report on progress in the field during construction and into the operations phase. Finally, the CWC also develops and promotes the introduction of new technology and techniques such as basin modeling and flood forecasting, for which it has received some UNDP support. Under AID's Irrigation and Management Training (IM&T) Project a new unit has been established in the CWC, the Irrigation Research and Management Improvement Cell (IRMIC).

The Water Management Division. This division of the Ministry handles several additional activities not covered by the CWC. It has monitoring units for development of minor irrigation (commands under 2,000 ha; command area development; groundwater development; and the large, inter-State Narmada Basin Scheme.

The minor irrigation development unit is concerned with externally funded minor irrigation projects. Thus, this unit was involved in the planning of USAID's minor irrigation projects in Maharashtra, Madhya Pradesh and Himachal Pradesh (the Chief Engineer for the Narmada Basin Scheme concurrently serves as the Chief Engineer for the minor irrigation unit). However, the principal difference for minor surface irrigation schemes in contrast to medium and major ones is that individual projects are not reviewed for technical or cost compliance by the Center, nor are they approved and sanctioned individually by the Planning Commission.

The activities of the command area development unit derive from the well-known program begun in 1974 to improve the performance of several of the large surface irrigation systems. The original program approach emphasized interdepartmental coordination, the development of chak-level facilities and on-farm activities such as land leveling. The units present activities are concerned primarily with chak level development.

Groundwater activities are implemented by the Central Groundwater Board (an interdepartmental body). The Board maintains a network of reference wells across India to monitor groundwater levels and assess groundwater potential in areas which the States identify as critical. A more recent function of the Board is to review all proposals for medium and major irrigation projects to assess their potential groundwater impacts.

Ministry of Agriculture

Like irrigation, agriculture is a State subject. The Ministry has three departments, Agriculture and Cooperation, Food and Agricultural Research and Education. The principal function of the Ministry is coordinative. It assists the States with planning, budgetary and policy support functions. However, the Ministry does have some limited national programs where it has an executive function in close coordination with the States; for example, watershed protection in certain critical areas.

Indian Council for Agricultural Research (ICAR). The ICAR is a registered society set up under the Societies Registration Act. The President is the Minister of Agriculture. The Director-General of ICAR is also the Secretary for the Department of Agricultural Research and Education. The Council recieves a lump sum grant from the Government of India each year from Plan funds and a special cess on agricultural produce. ICAR is charged with providing countrywide coordination for research, education and extension education in agriculture. ICAR is also charged with providing financial, technical and management support for research carried out at the following: 23 State agricultural universities; three national research centers and 35 central institutes; 63 all-India coordinated research projects; and 475 ad hoc research projects at various institutions throughout India.

Besides research on crops, plant protection and agronomy, ICAR is responsible for research on soil and water management, agricultural engineering, animal husbandry and fisheries. The ICAR activities are primarily directed at controlled research on various components of water management at the station, field plot or farm level. Therefore, ICAR would probably not do large-scale action-type or pilot level research on irrigation systems, as contemplated in the USAID-supported irrigation projects (with the possible exceptions of limited activities by its Water Technology Center headquarters at Pusa).

Planning Commission (Ministry of Planning)

The Planning Commission, which is chaired by the Prime Minister, is responsible for both the long-range development strategy and the allocation of budgetary resources. It sets medium-term development goals in its Five Year Plan, attempts to coordinate supporting roles among various divisions and activities, sets policy and allocates fiscal year budgets. The Commission specifically approves and sanctions all medium and major irrigation project schemes. The Commission is supported by technical advisors representing various areas. It has an Irrigation Advisor, who plays a significant role in influencing plans and policy. Funds from external sources are included in revenue projections for the plan against which budgets are balanced. Thus, foreign assistance funds are not budgetary add-ons, but must be included within the planned ceilings and appropriations. Like the Ministry of Irrigation, the Planning Commission may implement special study commissions such as the Irrigation Commission which in 1972 produced an assessment of irrigation and recommended goals. They have also commissioned at least one report on the operation of Command Area Development Authorities (CADAs).

Department of Economic Affairs (Ministry of Finance)

This Department coordinates all external assistance programs including the technical and legal details of fiscal transfer and

accounting, loan agreements, etc. It also designates the technical agency which a donor such as USAID must contact to discuss specific program interests.

University Grants Commission (Ministry of Education)

The University Grants Commission coordinates allocations of central funds to universities and will be involved in the university development component of the IT&M Project.

Agricultural Refinance and Development Corporation (ARDC)

The ARDC provides credit for well and lift irrigation development (including electrification) and for chak and farm level land development. The ARDC receives capital allocations from the Center and through anetwork of State, district and local level development banks loan packages refinanced by ARDC are developed. ARDC has a technical cell which supervises the loans with assistance from technical agencies such as Soil Conservation and State groundwater development agencies.

Institutions for Irrigation in Maharashtra

Minor Irrigation

There are approximately 2 million ha of irrigated land in Maharashtra. The irrigated portion covers approximately 11 percent of the cultivatable land in the State. About 60 percent of the irrigated area is supplied by wells and the remaining 40 percent is irrigated from surface supplies.

In Maharashtra minor irrigation can be divided into three institutional types: State-supported irrigation projects built and managed by the Irrigation Department; local irrigation with commands of less than 100 ha controlled by local government units; and private irrigation, including individually-owned wells and lift schemes owned and managed by farmer cooperatives. The estimates of the average command area size of the total areas irrigated, and the percentages of both all minors and all irrigation falling within each of these three institutional types (as of 1980) are set forth in the following table.

This table does not reveal the intensity of irrigation that is possible across the institutional types. The State-supported and local sector systems are usually only designed to supply water in the kharif and rabi seasons. However, wells are often operated during the summer or hot season as well as from March through May. Thus, wells can be used to supply water for both hot season crops and perennials such as sugarcane

Institutional Type	Average Size of Command (ha)	Total Areas Irrigated (ha)	Percentage of All Minors	Percentage of All Irrigation
State sector minors	150	158,000	11	8
Local sector minors	20	103,000	7	5
Private sector minors	1.3*	1,207,000	82	61
TOTALS		1,468,000	100	74

*1.3 ha is the average of the well commands. Lift schemes, also included in this category, have an average command of 200 ha.

and grapes. Therefore, although they cover about 80 percent of the minor commands, they may be responsible for as much as 95 percent of the crop value produced under minor irrigation.

Minor irrigation as a whole is growing at the rate of about 5 percent each year. Almost three-fourths of the growth is in the private well sector. The private lift sector is the fastest growing type on a percentage basis, suggesting its institutional viability, but it is growing from a very small base. Public sector minor irrigation is being expanded at a rate sufficient to maintain the same relative share which existed in 1980.

In summary, individual farmers own, operate, maintain and finance (with some important subsidies) most of the irrigation in Maharashtra. Furthermore, they provide an overwhelming share (possibly 95 percent) of the total value of production from the minor irrigation sector.

State Support for Private Sector Irrigation. Although wells and lift irrigation cooperatives are initiated, constructed, owned and managed by private farmers and groups, the public sector plays a vital role in these private sector activities. At present the public role in well development is essentially limited to finance and electrification. Most lift schemes are supplied with water pumped from tanks, canals or river channels with assured flows from major or medium projects. While the Irrigation Department does not own, finance, construct or manage the lift schemes, it provides and charges for the water.

In Maharashtra private sector irrigation is mainly financed through the Land Development Bank and the Cooperative Banks. These banks have a myriad of subsidy schemes which are vital for financing private sector minor irrigation. In addition, technical assistance is provided by the Groundwater Survey and Development Agency which advises farmers on where to dig wells and advises the banks on where and when to restrict further development due to over-exploitation.

Unfortunately, we have little information on the source of technical input for design, construction and management of private sector minor irrigation. We were unable to uncover a careful investigation of the nature and extent of private sector engineering such as irrigation services through consulting firms or equipment dealers. Obviously, understanding how to encourage the expansion and improvement of the private irrigation sector is among the more important institutional issues concerning minor irrigation in Maharashtra.

Local Sector Irrigation. Prior to independence minor irrigation tanks and other works were a community responsibility. However, after independence this responsibility was shifted to the Irrigation Department for commands over 100 ha and to the Zilla Parishads (district governments) or to village panchayats for commands under 100 ha.

Marketing and Processing Institutions. In Maharashtra much of the development, impulse and economic energy behind lift scheme cooperatives and private wells can be traced back to the direct financial and organizational involvement of processing and marketing cooperatives. This is most common with the large sugarcane industry, but the same process is taking place with other commodities like grapes around Sangli and onions. When a lift cooperative is formed, the predominant pattern is to obtain financing based on underwriting guarantees from a sugarcane processing cooperative. This is also a common pattern for underwriting construction loans for farmers with insufficient credit standings. The dynamism in the private lift sector, and to a lesser extent in the well sector, is dependent on the probability of high value cash crops which is unlocked by the processing and marketing entities.

State Sector Irrigation

At the political level, the Irrigation Department (ID) is headed by a Minister assisted by a Minister of State and two Secretaries (who are usually irrigation engineers), one for Irrigation and one for Command Area Development. Medium and minor irrigation is handled by the Irrigation Secretary. For field operation, the State is divided into six regions, each headed by a Chief Engineer who is responsible for surveys, planning, design, implementation monitoring, operation and maintenance for major, medium and minor schemes under his charge. Large major schemes are organized under special project Chief Engineers. The ID is also responsible for collecting fees for water on State-financed projects. Regional organizations follow the usual pattern of geographical circles headed by Superintending Engineers with Executive Engineers and their staffs. Staff support for the Irrigation Secretary is organized under three divisions, each headed by a Chief Engineer. The Department employs about 9,000 engineers.

Normally, development below the 40 ha outlet is carried out under the direction of the Soil Conservation Wing of the Department of Agriculture under a Deputy Director of Agriculture for Land Development.

This work is normally financed by the farmers, usually through institutional credit. Under new policy the Irrigation Department constructs watercourses and field channels down to farm gate on 2 ha level, but only on internationally-funded projects. The Wing is organized into Divisions and Subdivisions who conduct the field operations. Soil Conservation technicians are diploma graduates in general agriculture. Training programs are being implemented to improve the engineering technical skills of Soil Conservation technicians.

The Groundwater Survey and Development Agency has responsibility for development and utilization of groundwater. The Agency is well staffed with professionals. It assesses the potential and extent of groundwater development in the State's 1,481 watersheds. Control of over-exploitation is through the credit system where wells are financed by institutional credit. There is no mechanism, however, for controlling this where private financing is used.

An important irrigation regulation imposed by the State sector is the pattern of water distribution called Shejpali. Under Shejpali farmers apply for enough water to irrigate each seasonal crop. These applications must be in line with the crop mix determined for the particular command by the Agriculture Department at the time the project was planned. In minor State projects only seasonal rights for each kharif or rabi season are granted. Therefore, farm planning and flexibility is limited by an annual right which must be reissued each year and is designated for irrigating specified crops in specified seasons. Furthermore, allocations for summer are seldom made; thus, perennials are precluded. For each season the canal master assigned to each minor by the Irrigation Department sets up a rotational schedule of water delivery, called a Pali Patrak, based on the water rights that have been granted.

Irrigation Institutions in Madhya Pradesh

The most striking characteristic of irrigation in Madhya Pradesh, India's largest State, is its limited coverage. Only about 11 percent of the State's agricultural lands are under irrigation compared to 31 percent for India overall and the irrigated area is only about 2 million ha, which is about the same total as in Maharashtra. This total irrigation command includes all land served by the State, local and private sectors.

Groundwater and the Private Sector

Forty-three percent of the State's irrigated area is served from privately developed dug wells and tubewells. Considerable scope for additional development exists. Only about 10 percent of the State's groundwater potential has been tapped thus far. The State government is involved in providing important backstopping services for this private

development. The Irrigation Department has three units assigned to groundwater activities. These are headed by a Chief Engineer for Groundwater Surveys, located in Bhopal. His staff conducts surveys, prepares guidelines for collection of hydrologic and hydraulic data, monitors observation wells and sets design criteria for groundwater development.

The Agriculture Department provides technical guidance for dug well schemes. Credit for groundwater development is available through the Agricultural Refinance and Development Corporation. Thus far this private sector involvement in groundwater is not being driven by the involvement of commodity and marketing groups, as is happening in Maharashtra.

Local Sector Irrigation

In previous centuries irrigation was identified with the small tanks which dotted local communities, but their importance has declined with recent emphasis on larger State-supported irrigation projects. Now only tanks with commands of less than 40 ha are the responsibility of local government, with assistance from the Agriculture Department. However, there are serious difficulties with this because of the limited development of the panchayat system in Madhya Pradesh. While the Panchayat Act was passed in 1962, the Zilla panchayats intended at the district level have never been established. There are panchayats at both the block and village levels and village panchayats are assigned responsibility for minor irrigation, along with many other responsibilities. However, their contribution in this area seems to have been constrained because of their limited financial resources and powers. Little more is presently known about the full extent or status of irrigation facilities in this sector.

State Sector Irrigation

The Irrigation Department is the major actor in the present irrigation scene. It is responsible for the planning, design, construction and operation of all surface irrigation systems commanding an area larger than 40 ha. The Department is also charged with administrating groundwater development.

Irrigation activities are spread over three departments, each represented by a Minister of cabinet rank and headed by a Secretary. These departments are concerned with: major and medium projects; minor irrigation; and the major schemes being planned in the Narmada Basin, the largest consolidated irrigation project in the State. USAID's minor irrigation subprojects, though located in the Narmada Basin, are the responsibility of the Minor Irrigation Department. The Minor Irrigation Department has the usual setup of engineering staff headed by an Engineer-in-Chief who in turn directs his staff of Chief, Superintending, Executive, and Assistant and Sub-Engineers.

At the base of the departmental hierarchy are field staff known as amins, who are expected to keep revenue records, assess irrigated areas for revenue and collect irrigation cesses. They draw up agreements between farmers and the Irrigation Department concerning the crops farmers plan to grow and the water they should receive. They also help Sub-Engineers distribute water and maintain the systems. These responsibilities are too burdensome to be carefully executed considering that an amin's jurisdiction may exceed 1,000 ha. Furthermore, the field staff also lack proper transportation and needed incentives to adequately administer water deliveries and maintain adequate records.

A critical institutional role in the State-managed tank systems is that governing water distribution. According to the Irrigation Department's rules, water is allocated to farmers on the bas ; of an agreement-cum-demand system. This allocation procedure begins with each farmer entering into a short- or long-term (for rice production) agreement with the Department to irrigate certain lands. The agreements cover kharif and rabi crops but not perennial and summer crops. After the water allocations needed to meet these agreements are aggregated, the Department establishes a water supply schedule which is then adjusted in accordance with the availability of water and the amount needed by the farmers. If the supply is less than the demand, only farmers who have long-term agreements with the Department can get as much water as they require.

Having established this general schedule, the Department then releases water in response to farmers' demands. In practice, releases are made as the total demand builds up, not in response to the individual demands of each farmer. Thus, the Department decides on the precise time and quantity of deliveries. However, both the ability to measure and control water and the ability to provide information about water releases to the farmers are limited. Because of this, water deliveries are not timely and predictable and the farmers respond by continuing their traditional low intensity style of agriculture with the resulting productivity being similar to that of rainfed agriculture.

Irrigation Institutions in Himachal Pradesh

About 100,000 ha, which is approximately 16 percent of the net cultivated land in Himachal Pradesh, is irrigated. A relatively small portion (about 25 percent) of the present irrigated area has been developed by the Irrigation Department or is under its management and operational control. Most of the large remaining portion is made up of locally built and managed systems called community kuhls. Nearly all irrigation schemes in the State are minor systems. There are no major systems and only a few in the medium (2,000 to 10,000 ha) category. The most common irrigated systems are small surface systems supplied by diverting water from seasonal or perennial streams and from springs. Many of the traditional weirs used for these diversions are temporary structures constructed with the plentiful stones found in the streambeds.

State Agencies and Irrigation

Three State agencies are engaged in irrigation development, creating new commands, repairing and remodeling existing facilities and intensifying facilities at the watercourse level. In the order of their approximate levels of effort in irrigation development, these are: the Irrigation and Public Health Department of the Department of Public Works; the Soil Conservation Wing of the Agriculture Department; and the Rural Development Department.

Irrigation and Public Health Department. The major activities of this Department include the following: remodeling community kuhls and subsequently operating and maintaining the remodeled systems to the outlet level; constructing and operating public minor systems along with a few medium gravity irrigation systems; and constructing and operating minor lift schemes, using groundwater and/or surface water.

Unlike the irrigation departments in some other States of India, the Irrigation and Public Health Department in Himachal is newer and less well established as a specialized irrigation agency. The Department is a component of the larger Public Works Department, whose other major wing is the Department of Buildings and Roads. Prior to 1974 the several construction functions of the Public Works Department were combined and even now, staff may be shifted between the Irrigation and Building wings. This has important implications in terms of the degree of specialization that is both possible and desirable for the staff to achieve. It tends to infuse a common "construction" orientation to both wings of Public Works.

The public health activities of the Irrigation and Public Health Department are focused on constructing domestic water systems in rural areas, which is consistent with the construction capacities of Public Works. The Public Works Department has a noteworthy record of achievement in road construction. Starting with an extremely modest road system at the time of the State's creation, the Department has developed an elaborate network, which is quite remarkable in this difficult mountainous environment. The Public Works Department also appears to be having similar success with the domestic water projects. It is from this background that the irrigation group approaches irrigation development with the same construction orientation and "can-do" attitude.

The Soil Conservation Wing. The activities of the Soil Conservation Wing of the Agriculture Department include the following: installing groundwater irrigation systems (both tubewells and dug wells) primarily serving individual farmers, although some are provided to groups of small and marginal farmers; installing water harvesting facilities (collection tanks, check dams, etc.), to serve both individual and groups of farmers; and assisting farmers in developing watercourses to distribute water from the main system outlets of medium and minor irrigation systems.

Rural Development Department. This Department is strongly oriented toward work at the block level and work in collaboration with the village

panchayats. Its principal irrigation activities involve providing limited financial and technical assistance administered through panchayats to implement minor repairs and improvements for community kuhls.

Assistance to Community Kuhls

Community kuhls receive assistance from all three of the State agencies discussed above, and they are the most common mode of irrigation works in the State. Thus, a study of their development and performance provides an opportunity to compare and contrast the development strategies used by each of the agencies. On matters of beneficiary participation, the three agencies have very different strategies for assisting the community kuhls.

The Irrigation and Public Health Department will only provide assistance after the irrigation community, acting through the panchayat, passes a resolution agreeing to transfer operation and management of the system (down to the outlet level) to the Department. (Reportedly, there is now a State moratorium restraining the Department from taking over additional community kuhls.) Typically, the assistance involves repairing or replacing the diversion structure and improving the main canal. The post-assistance responsibility for operating and maintaining the main system facilities are shifted from the community kuhl to the Irrigation and Public Health Department. Thus, the Department's budget must be used for any future repairs or regular maintenance and Department staff will be permanently assigned to look after system operations. In theory, irrigation cesses should be levied to finance the system operation and maintenance services, but in reality, practically no collections are made.

In contrast to the Irrigation and Public Health Department's approach, neither the Agriculture nor Rural Development Departments take over the operation or maintenance of the community kuhls that they assist. When an assistance project is completed, system operation and maintenance remains the responsibility of the local group. Rather than trying to collect water fees, the Agriculture Department typically operates through subsidized loan programs, with farmers taking loans to develop chak facilities, for example. The Rural Development Department requires that local beneficiaries provide one-eighth of the project costs in-kind, such as by supplying labor or local materials.

CHAPTER III

THE INFLUENCE OF THE AID IRRIGATION PROGRAM ON INSTITUTIONAL CHANGE AND TECHNOLOGY TRANSFER

In retrospect, USAID's planning strategy at the ARD level had four identifiable goals. These were never formally stated, but are implicit in the scopes of work and day-to-day procedures of the office. They were: improve planning and construction of systems so that reliable water supplies meeting farmers' objectives are delivered at farmers' fields; rationalize economic evaluation and utilize economic analysis as a planning tool; strengthen the support environment for irrigation farming, including improved application of water to farmers' fields; and institutionalize reforms so that they persist in the planning, construction and implementation process.

Origin and Evolutionary Path of USAID's Irrigation Portfolio

For USAID, irrigation project development began with what might be called a "rapid appraisal" of a set of projects in a State rather than a single one.[1] Problems identified or suspected by design teams were discussed freely with Indian counterparts. Some were discarded, others were agreed upon, still others remained at issue. In this process World Bank experience was drawn upon freely, although not always accepted.

The problems that the Mission felt could be tackled through technical assistance expanded as Mission and Indian confidence grew. As stated in the Appendix, it was nil for Gujarat; was earnestly begun in the Rajasthan Medium Project; but for the Maharashtra Irrigation Technology and Management Project it included a broad range of technical issues from the farm gate to the dam, interaction with farmer organizations, maintenance of watercourses and farming practices. The range of training and technical assistance activities was expanded further in the Madhya Pradesh and Maharashtra Minor Projects. In the most recent project, the Hill Area Land and Water Development Project brought in positive requirements for user participation and watershed conservation, promoted fuel-tree cropping and increased use of fruit crops, among other innovations, in addition to institutional reforms.

Internalization of institutional reforms involved the linkage of: enhanced technical economic and social criteria for subproject

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[1] Chambers, Robert, 1983. "Diagnostic Methodologies for Improving Canal Irrigation Systems." Discussion Paper No. 8, Ford Foundation, New Delhi. See also Peterson, Dean F., 1984, "Systems and Technology for Improved Water Management," Water Management Synthesis Project, Utah State University, Logan, Utah.

qualification to mitigate problems identified by the appraisal; clarification of institutional responsibility for all elements of the system including agricultural production as well as water supply and distribution; training designed to deal with the planning and implementation of subproject criteria and utilization of trainees so that personnel and new procedures become imbedded in the regular process; and field studies to more fully define problems as well as techniques for their solution and to test the newly defined solutions. With the Maharashtra IT&M Project the concept moved toward regarding subprojects as advanced pilot or prototype projects.

Progress toward the implied goals was mixed. Technical features of reservoirs and canals and their improvement are best understood and changes can often be introduced with considerable confidence. But the evidence is clear that there are, nevertheless, serious shortcomings in the performance of main systems. Human behavior is a different matter. While economic shadow pricing and time discounting were introduced into economic analyses, this never became more than a test for eligibility. It was not used for ranking. Introduction of improved economic analysis in detailed planning is limited at best.

Main system problems are under the control of Irrigation Departments and involve both procedures and policy. Among the more important common problems are:

- Overly optimistic projections of command areas that can be irrigated by available supplies;
- Underestimation of system losses. This is aggravated by long canal reaches, often through unlined permeable zones;
- Inadequate consideration of actual irrigation requirements at field level and how these vary along with physical inability of the conveyance and distribution structures to meet these requirements;
- Lack of control and measurement structures;
- Inequitable distribution to chak outlets;
- Lack of orderly scheduling of water distribution; and
- Inadequate maintenance. Even a well designed system functions poorly if it deteriorates through lack of maintenance.

Many of the perceived interventions needed were external to the USAID projects as designed. This was no one's fault. Considerable effort went into trying to deal with the "externalities" with some limited success. The problem is a structural one. Many of the desired reforms were in the private sector or the responsibility of agencies other than Irrigation Departments. These include all individual farm land development, supporting infrastructure of markets, roads, input supply, extension, etc. and initially, communal watercourses and drains.

In the latter case, Center policy is to construct to the 8 ha level, but finding the financing is left to the States. For the Rajasthan MIP, because it was credit-financed, chak development was not included within the project. Subsequently, the IDs' solutions were to take over this function from the ADs on externally-funded projects.[2]

All chak and farm level functions seem to need increased attention. The more important ones include:

- Design and construction of command watercourses, field channels for distributing water from public outlets to individual fields and communal surface drains at this level;
- Continued operation and maintenance of command facilities;
- Land development on individual farms;
- Participatory development and implementation of efficient water scheduling;
- Water application to fields -- when, how much, how;
- Development of farmer organizations, increasing their capability and their capacity to negotiate with government agencies; and
- Optimal project-specific irrigation cropping patterns.

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[2]The status of policy in USAID's client States in 1982 as presented below shows that the Irrigation Departments resist integrating construction and O&M of command structures below the 40 ha outlets into their regular operations because of financing.

Responsibility for Watercourses and Field Channels

	Watercourses (40 ha cum 8 ha)			Field Channels (8 ha to fields)		
	Construction	Financing	O&M	Construction	Financing	O&M
Maharashtra	ID/AD[a]	Govt.[a]	Farmer	Farmer[b]	Govt.[b]	Fmr.
Gujarat	ID/AD[a]	Govt.[a]	Farmer	Farmer	Govt.	Fmr.
Rajasthan	ID/AD[a]	Farmer	Farmer	Farmer[b]	Farmer	Fmr.
Madhya Pradesh	ID/AD[a]	Farmer	Farmer	Farmer[b]	Farmer	Fmr.

[a]Only in the case of external assistance projects; otherwise the farmers are responsible.

[b]Except in Maharashtra Irrigation and Technology Management and Madhya Pradesh Minor Projects. From 8 ha to the field, channels are constructed initially using government resources. Means for recovering financing by GOM and GOMP were to be developed.

Especially at State level, non-irrigation agencies have tried to cooperate, but the incentive in material or political terms is weak. USAID explored the possibility that related expenditures, private and by other agencies, be included in reimbursements, but this did not seem practical. Some progress was made in the Maharashtra Minor and Hill Area Land and Water Development Projects through performance criteria for reimbursement, and in the case of the latter project, direct involvement of other agencies besides the Irrigation Department.

Government of India and State agencies have recognized the need for a broader disciplinary approach to irrigation management. Civil engineers concerned primarily with construction of hydraulic works need to have a better understanding of agricultural production under irrigation and the social and community relationships involved. Likewise, agriculturalists need to give more attention to managing irrigation water at the farm level and to the special problems of irrigated agriculture. Below public canal outlets new skills in water management such as rotational water supply plus more effective farmer organizations, along with better operation, maintenance and management are needed. Suggestions for in-service and university level training to broaden this base of expertise have been around for several years. With World Bank encouragement, Maharashtra set up the Water and Land Management Institute (WALMI) near Aurangabad for in-service training. To date WALMI's activities have been impressive.

Following the 1980 Sector Review Team visit, USAID began discussions regarding support of a training program with the GOI Ministry of Irrigation. Drawing on conceptual plans under discussion in the Central Water Commission, the current Water Management and Training Project was developed. This project is viewed as supportive of the present USAID-financed State projects and the extension of new principles and techniques, especially of integrated irrigation water management, in the country generally. It supports training in the four States mentioned earlier plus Tamil Nadu as a step towards a national training activity.

Even when extended globally, the training program must be accompanied by institutional changes in order to be very effective. It will need to reach down directly to grass roots needs at village and command unit levels. From the water supply and distribution side, under conventional arrangements for operation, maintenance and management junior irrigation officers normally administer divisions of 2,000 to 5,000 ha assisted by canal inspectors, repairmen and patwaris who manage distribution at local level. From the agricultural support side, each village level worker (extension officer) is responsible for providing agronomic support to 800 farm families, but this is not specifically geared to irrigated agriculture. Its lines follow the public administrative structure which overlaps irrigation projects and includes rainfed agriculture also.

Indian officials are generally conscious of the fact that these inadequate and thinly spread services are not sufficient for the needs.

Under Command Area Authorities in some States junior officers become directly involved at the field level. In Maharashtra those receiving in-service training in irrigation management are assigned exclusively to Command Area Development Authorities (CADAs). In Tamil Nadu, below outlet responsibilities are handled by a separate Agricultural Engineering Department in the Ministry of Agriculture. Future activities in that State will be exclusively in OM&M because irrigation potential is fully developed. Other States are considering alternative arrangements, such as a separate irrigation water management cadre.

Except possibly for the last item in the list (not now addressed except in the Maharashtra Minor), the various tasks involved in chak development do not seem to fit within the classical role of the agricultural extension agent nor, except for the first two, within Irrigation Departments where they would compete for scarce money and personnel resources which the departments would prefer to spend on extending canal commands. Hypothetically, the farmersthemselves, if properly organized, could assume many of these tasks, but this has not been tested. Clearly they could not do it without technical and programmatic support. The idea of command area development was to deal with these deficiencies, but success has been marginal. Actually, USAID's information base about how and how well CADAs actually function is weak because CADAs have been restricted to major projects which were not in USAID's portfolio.

In its approach USAID, with little success, sought ways to shift a share of financing from hydraulic infrastructure to support of other components of irrigated agricultural production. This was difficult, partly because of USAID's preference for reimbursing government agency expenditures in contrast to support of private investment and a lack of institutional candidates. Credit institutions are in place, but they do not view special programs of supervised credit with favor. The closest U.S. analog is the financing program of the Soil Conservation Service; the Indian Soil Conservation Services within the Agriculture Departments are candidates, but their expertise is largely in soil erosion control; the other candidates are the CADAs. The Team expects that USAID's efforts under its present irrigation portfolio will result in irrigation systems that work somewhat better, but there still remain some major deficiencies to optimal operation.

General Description and Objectives of the USAID/GOI Irrigation Portfolio

The USAID portfolio of projects related to irrigation is directed principally at canal irrigation. For the most part it can be thought of as a single Canal Irrigation Program carried out through the GOI Ministry of Irrigation with the projects in each State as subsets of the program and the IM&T Project providing training and field studies broadly applicable to them all. The five State projects projected the

construction of: 9 medium (2,000 to 10,000 ha) subprojects in Rajasthan; 13 medium subprojects in Maharashtra; 50 minor (100 to 2,000 ha) subprojects in Madhya Pradesh; 90 minor subprojects in Maharashtra; and 150 minor (averaging about 100 ha each) and numerous (up to 1,700) smaller (less than 100 ha) subprojects in Himachal Pradesh. Each new State project has evolved from the experience in developing (but limited experience in executing) its predecessors and thus each, although more complete in terms of the software package, is more complicated to execute.

There have been modifications in the number of targeted projects as detailed appraisals have proceeded. The Rajasthan Project Paper projected 15 to 20 subprojects and Maharashtra apparently will be reduced to nine. Because the minimum time for completion of medium irrigation subprojects is five years, and AID's reluctance to approve projects for longer than five years' duration, few, if any, new medium irrigation subprojects, as planned, will be completed by the AID project assistance completion date. For minor projects the plan is that many subprojects will be essentially completed prior to project completion dates.

Study and training activities are included with each of the construction projects to provide needed information to upgrade certain design criteria, test hypotheses and transfer technical information to Irrigation and Agriculture Department staff. In addition, the Irrigation Management and Training Project (IM&T) is designed to develop the Indian capacity to upgrade the general technical level of Irrigation and Agriculture Department staff and farmers in irrigation management; plus do action research or studies on operating systems to develop and test solutions aimed at improving canal irrigation systems performance.

Approximately three-quarters of the USAID/GOI irrigation portfolio is for concessionary financing of reservoir and canal irrigation construction and development below the outlet. From 35 percent of the construction funding falls in the latter catgory. The remaining one-quarter of the total is grant money to finance the study and training activities discussed above, most of which are directed below the outlet. The loan and grant monies combined make up a one-third billion dollar portfolio.

The USAID irrigation portfolio is presented as a step forward in promoting better canal irrigation systems performance through improved system planning, design and construction criteria plus training to stress improved irrigation management wit. emphasis below the outlet and on farmer participation. The basic improvement targets specified include:

1. More careful analysis of and tighter design criteria for hydrological and primary water distribution aspects directed at the development of more economically rational projects;

2. More attention to seepage losses and usage of canal lining;

3. More flow measuring and cross-regulating structures;

4. Design for rotational water delivery with controlled flow rates often in units of 30 lps (1 cfs) to be delivered for specified time intervals to the land area served in accordance with pre-selected cropping programs, cropping intensities and realistic application efficiencies;

5. More accurate surveys of the command area with 0.2 to 0.3 m contours plotted on large layout maps where 1 cm represents 10 to 20 m;

6. Extending the water delivery network down to the 8, 5 or even 2 ha level, using both social and physical criteria in designing the farm distribution layout;

7. Providing demonstration chaks (actual farm units) in which land leveling and full irrigation development is provided along with special assistance with the selection of HYV seeds and proper fertilization;

8. Assisting in organizing farmer participation in the Operation, Maintenance and Management (OM&M) of their irrigation systems from the outlet up to the main canal inlet as well as down to each farm unit;

9. Special studies to provide the additional knowledge on engineering, agronomic, socioeconomic and institutional matters needed to meet the above targets;

10. Action research projects that allow the testing of innovative technologies and management strategies in the context of live irrigation systems;

11. Developing in-country training capability and the output of trained personnel which are needed to meet the above targets; and

12. Indirect effects on the OM&M of State projects through improved systems, farmer participation and general training of Irrigation Department personnel;

13. Increased multidisciplinary, interagency and community participation in providing resources and in planning and OM&M; and

14. Increased attention to watershed protection within the command area and introduction of new crops, particularly in hill areas.

Specific Impacts on Institutional Change and Technology Transfer

This section addresses the impacts of USAID's irrigation portfolio in the following specific areas: state and national policy dialogue; organizational structures and staff development; procedures for system design and construction; operation, maintenance and management (OM&M); probable productivity and economic impacts; rural equity and employment; irrigation department linkages with other local institutions; USAID's relationship with other donors; conjunctive use and groundwater development; and extensive and intensive system design.

State and National Policy Dialogue

The USAID FY 86 Country Development Strategy Statement for India, pp. 14-15, outlines its objectives in the policy area for the irrigation program as follows:

> In India as elsewhere the IMF tends to have a comparative advantage in dealing at the macro-economic level, the World Bank at the level of sector economic policy and AID at the sector program policy level. USAID's primary emphasis . . . will be on further reform of key program policies and more effective policy implementation in the major subsectors, particularly irrigation . . . USAID expects to support positive policy changes in all of these areas.

The policy focus of the irrigation portfolio focuses on program implementation policies and procedures rather than on more general policy issues. This has led USAID to focus on policy almost exclusively at the State level. This will change somewhat with the entry of the IM&T Project. This project has important implications for irrigation policy and planning capacity at the Center and for broader technology dissemination and transfer through the Center.

While there have been efforts to alter policies and procedures in many different areas, the most important focus has been on policies and procedures for system design. In this area some important achievements appear to be under way, as will be discussed later. Other useful, but less impressive, efforts have been undertaken in institutional policy, in conjunctive use/groundwater policy and in policies relating to the construction of extensive versus intensive systems. Discussions of these areas of policy and program activity is included in the following sections of this chapter.

USAID's program appears to have been appropriately focused toward specific program implementation policies and procedures where its projects provide pilot testing possibilities. USAID has neither ventured deeply, nor been invited by the GOI to venture deeply into more general State and national irrigation policies. It is unlikely that such

dialogue would be feasible for USAID as long as its irrigation program continues to be an Irrigation Ministry program. This is evident because USAID only finances about one percent of the irrigation development programs the Ministry oversees.

It would be more feasible to have a serious policy dialogue if USAID were to shift its future program focus to irrigation projects outside the Irrigation Departments. Two such probabilities would be local sector irrigation or groundwater development.

For surface irrigation the local sector generally involves small-scale irrigation projects with less than 100 ha of irrigated area. Typically, the Irrigation Department's "minor" jurisdiction begins with projects over 100 ha. In Maharashtra the local sector accounts for about 5 percent of the irrigated area compared to 8 percent for other minor irrigation. The local sector is relatively ignored by both public policy makers and external donors. Therefore, it may present USAID with an opportunity to have a significant policy dialogue. The local sector's share of total irrigation does not appear to be much smaller than the Irrigation Department minor irrigation sector where USAID has devoted a considerable share of its project investment with much less chance of policy dialogue.

The area of groundwater policy has been identified by the GOI Planning Commission's Sixth Five Year Plan 1980-1985 (page 140) as a priority issue. Groundwater, which is also included in minor irrigation and is largely in the local sector, promises to be the subject of an important continuing policy debate.[3] Unlike the local surface irrigation sector which is small, the groundwater sector irrigates more than half of the irrigated area in India. It accounts for perhaps 80 percent of the value of total irrigated agricultural production at present[4] and contains much of the untapped potentials.[5] Major policy issues influencing future groundwater versus surface public investment choices are moving to center stage. The fledgling groundwater institutions involved may be willing to open the door to significant policy and technical dialogue with USAID.

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[3]B.B. Vohra, Land and Water Management Problems in India, Second Edition, Ministry of Home Affairs, New Delhi, 1982, p. 124; and N. Pant, "Issues in Irrigation Development," Economic and Political Weekly, Delhi, July 23, 1983, p. 1315.

[4]See Sixth Five Year Plan data discussed in S. Daines "Irrigation Policy in India: An Evaluative Analysis of Policy Trends and Issues," Logan, Utah, 1984, 84 p.; discussion on relative share of groundwater in agricultural production, pp. 6-7.

[5]See current literature and groundwater potential estimates as reviewed by R. Chambers, "To the Hands of the Poor: Water, Trees and Land," Paper for the Institute of Economic Growth, Silver Jubilee National Seminar Programme, Delhi, April 1984, pp. 10-11.

Organizational Structures and Staff Development

The impacts which USAID's irrigation portfolio has had on the organizational structure and staffing patterns in the Irrigation Departments in the various States are interrelated.

Organizational Structures. Changes in the organizational structure of the Ministry of Irrigation and the State Irrigation Departments (IDs) are happening in direct response to the USAID irrigation projects. However, as yet the changes are insufficient to achieve project objectives, as discussed below.

As a result of the USAID projects, several new organizational units have been established at the federal, State and local levels. For example, the Maharashtra IM&T Project has resulted in several new units within the Central Water Commission being established or planned. In the State of Madhya Pradesh a State-level Minor Irrigation Committee has been established. In Himachal Pradesh district committees are planned to oversee project activities at that level. One can conclude that the organizational charts of the IDs with which USAID is working look different, or will look different, as a result of the projects. The projects are getting in place the various new units required to administer the conventional design and construction activities of the various IDs such as overall policy committees, appraisal and supervision cells, monitoring cells, etc. However, two problems are evident.

First, the IDs are assuming tasks that they cannot implement and which would be better carried out by others. (This problem interacts with the problem of developing an overly narrow range of cooperating institutions as will be discussed later.) A clear example of taking on too much is the present plan in Madhya Pradesh in which the ID is establishing a coordination cell for research and training entirely with staff from the ID, most of whom have no prior training or experience with research. It will be impossible for this group to conceptualize and organize a vibrant research effort that will provide new lessons for the ID as envisioned in the project plans. Rather than simply having the ID absorb this research function as another standard activity of the Department, researchers need to be involved in the policy-level Minor Irrigation Committee and experienced research groups need to have the lead responsibility for whatever research problems are identified for investigation.

Second, none of the changes in organizational structure are resulting in clear and focused attention to water user organizations. There are no new cells being created in the IDs to deal with this topic (except as some units dealing with action research or special studies might touch on this matter). Furthermore, no significant changes in staffing patterns are being pursued. However, there may be the suggestion that irrigation field staff will add this activity to their existing responsibilities.

A most important deficiency is that the IDs have not turned to outside experts to involve them in conceptualizing the issues and identifying pilot programs or special studies in any of the USAID projects. There is widespread but not unanimous opinion in the IDs that if farmer organizations are required the Departments have the capacity to establish them. Therefore, there has been no move to involve outside experts such as social science groups studying the topic or private voluntary agencies experienced with organizing rural people. There is a clear need to reverse the inward looking tendency of the IDs. They should be more strongly encouraged to call in other institutions to begin work on this crucial element. The USAID projects in India, unlike USAID irrigation projects elsewhere in Asia, lack any credible experiences with this now widely accepted component of irrigation development. We believe this will continue to be the case if organizing irrigation groups remains an ID responsibilty.

Staffing Patterns and Staff Development. The USAID irrigation projects are resulting in changes in staffing patterns and staff development in the State IDs. Many of the impacts flow directly from the changes in organizational structure such as new committees, units and cells, as described in the previous section. Two basic trends in these activities are important. Many of the changes in staffing patterns are moving ID staff into roles for which they are poorly equipped and for which they are unlikely to be rewarded by the standard agency procedures. Furthermore, much of the staff development that is occurring is oriented toward developing skills and capacities for work below the outlet at the chak level.

The point that irrigation staff members are being moved into roles for which they are not prepared, and unlikely to receive professional rewards, has been illustrated in the previous section. Here we wish only to make the additional point that this represents a diversion from other more central tasks of the IDs. Elsewhere this report argues that there is a large need for improved planning and design, management and operation of the main system facilities of the irrigation systems for which the Departments are responsible. A critical factor in achieving that goal will be the creation of staffing patterns and the development of staff capacity for system management. Thus, there is the need to direct staff development efforts and rearrangement of staffing patterns to that end.

The second point to note is that much of the staff development that is occurring is oriented toward skills and capacities to work below the chak level. There is less training planned or under way for improving staff capacities to better design, operate and manage the main system facilities and increase the probability of a reliable water supply to the various farmer outlet points. As is noted elsewhere in this report, there is a need to reorient project attention to the central and critical functions of the IDs above the chak level. To support this redirection, staffing patterns and staff development activities will need to be developed that address these functions more clearly.

Summary. In summary, we find the following problems with the present institutional development and staffing efforts:

- The IDs are directly assuming many tasks which can only be, or could only be, or could better be, implemented by other groups working in collaboration with them. The present set of institutions being involved with the IDs is overly narrow. Important groups are missing from the needed network; in particular, technical and socioeconomic researchers, management specialists and resource groups experienced in organizing farmers;

- No organizational arrangements are being established to deal with the formation or strengthening of water user organizations;

- Many of the changes in the staffing patterns of the IDs involve merely moving Departmental staff into roles for which they are poorly equipped and for which they are unlikely to be rewarded by the standard agency procedures; and

- The staff development that is occurring is too narrowly oriented toward developing skills and capacities for work below the outlet level at the expense of overlooking critical needs above the outlets.

Procedures for System Design and Construction

While the portfolio of irrigation projects is still very young (with Rajasthan Medium Project being the only project nearing completion), the IDs appear to be making a serious and what holds promise of being a successful effort at following the specified design and construction guidelines. For qualification, each subproject candidate is replanned according to USAID criteria and an appraisal including an estimated ERR is made. During field and office visits we observed or learned of the satisfactory inclusion of improvement targets (listed under "General Description and Objectives of the USAID/GOI Irrigation Portfolio") (2), (3), (4), (5) and (6) listed earlier. Details of the activities involved are included in Appendix B.

We are impressed by at least one example of what appears to be a relatively foolproof design (and implementation) for accurate, controlled and uniformly equitable water deliveries (at the 40 ha outlet level) on the Thikaria Minor of the Gambhiri Project in Rajasthan. We also observed the results of a careful execution of the design phase of rotational water delivery channel networks to the 8 ha chak level with field chanels to each farm field on the Sina Medium Project (which is part of Maharashtra Irrigation Technology and Management Project) in which both physical and social criteria were followed as closely as possible. Furthermore, we found the use of more accurate topographic surveys as specified by USAID becoming generally accepted throughout

Maharashtra. These detailed surveys are essential for accurate system design below the main canal distribution system.

Unfortunately our findings were not all positive. While we compliment the careful execution of the design of the rotational water delivery channel network on the Sina Medium Project, we are rather appalled at the complexity of the rotational schedule. To execute as designed will require adjusting flows from the main delivery system into the numerous minor canals at random times day and night during each water turn. In addition, the rotational operations along the minor canals is also complex. This added operational management responsibility plus extra maintenance responsibility associated with the watercourses will present a difficult problem for the ID, especially in view of the fact that the Operational Management and Maintenance (OM&M) budgets have not been increased. We might also point out that the young Assistant Engineer (AE), who is so very patiently executing the designs and teaching the other AEs how to do the same, learned "how to do it" during a short course at WALMI in Aurangabad. While this is evidence of the trainabilty of ID engineers and the potential of the spread effect, the complexity of the schedule adopted raises serious questions concerning course content.

We are also somewhat concerned with the slow startup of technical training and special study activities associated with the Maharashtra Irrigation Technology and Management (Medium) Project. However, we expect that much of the reason for this is that these are new and unfamiliar activities which the Irrigation Department is not equipped to handle. Along with the startup problems, we feel that there is a tendency to be too flexible with the training in terms of course content and the subsequent work assignments of personnel being sent for training; but too much rigidity in adhering to the illustrative special studies proposed in the project papers.

Our major technical/economic concern is with the projected economics for the Maharashtra projects. The disturbing projections that are unfolding result from over-optimism in estimating construction costs and the hope of achieving 100 percent utilization with the USAID prescribed set of planning, design and construction criteria. Estimated costs for the IT&M (Medium) Project, after replanning and design, now appear to be about 55 percent higher than the values used in preparing the project paper. Furthermore, after a brief review of the Sina Project we find it difficult to imagine that the ultimate irrigation potential[6] projected in this design can ever be realized unless more (perhaps even excessive) emphasis is placed on lining of the main canal. In fact, we are inclined to suspect that even with all the watercourses and field distribution

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[6]The ultimate irrigation potential is the gross area that can be irrigated from the project during a design (full water supply) year for the projected cropping patterns and assumed water allowances after full development.

channels provided along with aggressive farmer organization/ participation, the utilization will be little better than average (which is 50 to 75 percent for mediums throughout Maharashtra). With increasing costs and reduced benefits, the economic expectations projected in the project paper could be substantially reduced. Much depends on OM&M. Even if the subproject at commissioning could meet full utilization needs, without greatly improved OM&M this would fall far short of expectations.

The cause of much of the problem leading to low utilization percentages results from what has been termed the planning gap.[7] In Andhra Pradesh the procedures being followed for planning of irrigation projects inevitably lead to an average shortfall of 30 percent in the area irrigated.[8] It is further reported that stretching the water more equitably would have the effect of increasing this gap further, perhaps to 50 percent or so. Unless USAID is more rigorous in the appraisal and project monitoring process, its projects will end up with a similar situation. Thus, where will the USAID projects stand in spite of all the effort placed below the outlet? The problem is aggravated on the minor projects which are appraised and monitored by a unit under the State Irrigation Departments rather than externally by the Central Water Commission appraisal cell as for medium projects.

Much of the cost overrun may be explainable if one considers the following comment by P.K. Row:[9]

> The officially reported cost estimates of works completed are overestimates of real costs incurred in project development and maintenance due to significant leakages, corruption and inefficiencies commencing with cost escalation in executing project works. The leakages are generally estimated to be around one-third of the official estimates. The accounting methods being what they are, the drag on the utilization potential gets reflected in the rest of the irrigated area leading to overestimated cost of providing water at the farm level. As a whole, it appears that only about half of the magnitude of officially estimated costs should be taken as real costs and pricing formulas evolved on this basis.

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[7] The planning gap is due to adoption of over-optimistic and unrealistic duties, inadequate water allowance, under-estimation of seepage and other losses, over-estimation of dependable yields at the point of diversion, etc. It can be expressed as the difference between the area planned and the area that can be irrigated with the full water requirements of the crops at a reasonable level of project efficiency.

[8] See Report of the Commission for Irrigation Utilization, Hyderabad, November 1982.

[9] Remarks on Cost Recovery and Irrigation Water Pricing, Overseas Development Institute Irrigation Management Network Paper, November 1984.

There is little doubt that as the increasingly difficult, more expensive projects remaining are tackled, this extra burden cannot be afforded.

In summary, the Team finds the following with respect to the present stage of the physical development efforts:

- The physical performance to date appears to be addressing improvement targets (2), (3), (4), (5) and (6) from farm fields up through the minor canals in a reasonable fashion with some rather outstanding examples of success as well as some need for caution;

- It is too early to evaluate targets (7), (9), (10), (12), (13) and (14);

- The training (11) is moving and there is some evidence more careful attention must be given to who gets trained and the practicality of the course content;

- Our greatest concern is with improvement targets (1) and (2) in relation to main canals and (8) and USAID's own individual subproject appraisal, monitoring and evaluation which we suggest is at least partly responsible for the bleak B/C outlook which we project. This is partly due to increased costs, and partly due to unrealistic expectations in terms of the true irrigation potential being created; and

- By USAID's heavy stress under its grant program (software) on below the oulet problems and relative lack of attention elsewhere, overall irrigation system performance will probably remain disappointing. The heavy stress on below the outlet problems may be diverting needed attention from the equally serious need for designing for realistic levels of irrigation potential and addressing (with significant resources) the critical OM&M problems. Without sufficient OM&M there is little hope of providing the consistently reliable and timely water deliveries needed below the outlet in order to induce farmers to operate, maintain and manage their joint delivery and farm irrigation application systems to achieve the hoped-for project production levels.

Operation, Maintenance and Management (OM&M)

Any impact which USAID's irrigation portfolio will have on OM&M will be indirect through improved systems and better trained personnel. Within USAID's assistance project time frames only some of the minor subprojects will reach OM&M phase. The State projects which are principally directed at constructing new canal irrigation systems will provide better control of the water. This will be accomplished through: installing additional gates, checks, measuring devices and bypass structures for cross-drainage flooding; lining more canals; and implementing rotational water deliveries. States, by policy, did not

install lining on medium and minor projects, but lining is being required on channels in porous soils under USAID projects. Properly designed and constructed, lined channels are much easier to operate and maintain than earth ones. Farmers cannot illegally cut the banks as easily, weed growth and erosion is nil and water can be moved to new delivery points with less delay because the water runs faster. On USAID projects conversion to rotational water deliveries is being firmly encouraged. By requiring development of water scheduling on a rotational basis, the water demands should be more orderly and less ad hoc.

The major part of the Water Management and Training Project is focused toward OM&M. This should increase professional competence and bring more attention to bear on improved institutional arrangements to enhance OM&M.

Probable Productivity and Economic Impacts

Very little of USAID's irrigation portfolio has been constructed at this time. Therefore, assessing its probable impact on agricultural productivity and economic targets is difficult. However, the reasonableness of the estimates themselves can be assessed. This can be done using recent field data on the benefit achievements of other similar projects along with updated cost estimates from USAID's experience to date.

The three most mature USAID projects are in Gujarat, Rajasthan and Maharashtra. An evaluation of the Gujarat Project is not the most helpful since it contained few of the design elements which are now the core of the USAID approach. Furthermore, field surveys with benefit data are not available for Rajasthan. This narrows our assessment to Maharashtra, in which USAID has its largest State program. More complete details of the assessment which follows are included in Appendix C.

Benefit Projections. The Maharashtra Minor and Medium Project Papers are interpreted by the Team as estimating an increase in farmer incomes through irrigation of between US $350-400 per irrigated hectare in 1982 dollars, depending on differing procedures used by the Team and the Mission.[10]

A field survey of 800 farms on ID projects in Maharashtra was designed to measure the actual farmer benefits achieved.[11] The surveyed

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[10] B. Sen, Benefits from Surface Irrigation Projects, USAID, AR/RD, New Delhi, January 1985, p. 3.

[11] B.D. Dhawan, "Differential Income Inpact of Public Canal Irrigation in Maharashtra," In: N. Pant, ed., Productivity and Equity in Irrigation Systems, New Delhi, 1984, pp. 125-145. The surveys on which this analysis is based were made by Mahatma Phule Agricultural University in World Bank irrigated commands.

commands appear to be in areas of better than average soils, market proximity and groundwater availability in comparison to the USAID projects. The design and management improvement package included some, but not all, of USAID's planned improvements. The benefit realized from irrigation on the ID commands surveyed was approximately US $264 per irrigated hectare in 1982 dollars. With the site adjustments in mind, the USAID improvement package would have to perform about 30 to 40 percent better than the ID package to achieve these targets, but that does not appear to be outside the feasible range.

In Maharashtra a few Medium USAID systems have been designed. Average estimated construction costs in the project paper were Rs. 22,000/ha (1980 Rss). Updated estimates used in the qualifying appraisal with construction less than 10 percent completed are now estimated at about Rs. 33,800/ha (construction year Rs.) including price escalation to end of construction, a 54 percent increase.[12] The present average estimated cost of the seven subprojects so far approved is about Rs. 28,000/ha (1983 Rs.), presumably not including price escalation. The actual cost is likely to rise due to delays and cost overruns.

The area which will be irrigated by the Maharashtra project will undoubtedly be less than that targeted in the project papers. The reasons for these shortfalls may be grouped into two categories: construction delays and increased costs; and the estimates of the area which will be irrigated will not be achieved under actual operating conditions.

In dollar terms the estimated increases are less dramatic. The project paper was based on an exchange rate of Rss 9/$. Current rates (January 1985) are around Rs. 13/$. The project paper estimate translates to $2,444/ha; the current estimate, including escalation, to $2,600, or a 6 percent increase. From a financial point of view, the problem of increasing costs falls heavily on the Indians if current exchange rates prevail. AID would appear to have almost enough dollars to complete its share, but the Indians would have to raise 50 to 60 percent more rupees. From an economic point of view, the rupee costs are the relevant ones.

The practical effect of the cost increases in the case of USAID's projects will be a reduction in the number of subprojects financed and a consequent reduction in the target area to be irrigated. In the case of the Maharashtra Medium Project it appears that the effect of increased costs will be a reduction in the projected irrigated area from 87,000 ha to 50,000 to 60,000 ha.

The second problem which will undoubtedly reduce the target area actually irrigated by irrigation projects below that targeted is known as the "Utilization Problem." At the surface this "problem" is simply the

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[12]Mission estimates provided to the Team by Mike Walters and from the approved subpraisal reports provided by B. Sen to Dean F. Peterson, January 1985.

numerical reality that on the average, existing canal irrigation projects in India (and particularly in the Deccan Plain where AID projects are concentrated) irrigate only a part (30 to 45 percent) of the area their designs say they can irrigate. This underutilization appears rather intractable as it has not been influenced very much by the improved design and "below-the-outlet" efforts of a recent World Bank funded CADA and ID; however, where CADAs have had executive authority in contrast to just coordination, as in Chambal and Rajasthan Canal, utilization has been significantly improved.[13]

While there are many interesting and important engineering and system management issues raised by the utilization problem, it also has important implications for the economic analysis of systems. From our review the main analytical problem appears to stem from the lack of reliable data rather than from methodological defects in the economic analysis. Without the constraint of reliable field data many seemingly reasonable projections may be made using accepted benefit cost procedures. Internationally accepted engineering/economic project design and appraisal procedures often produce projections which fail to accurately reflect India field realities. While the projections might be be met or nearly met given ideal OM&M from the reservoir to the farm, to assume this will happen is unrealistic. OM&M is already under-financed and clearly deficient even on main systems, and the financing and institutions are not in place to cope with it below public outlets.

The Team feels that the economists did not properly adjust engineering estimates based on the best available data about what is actually happening in the field with existing projects. Such field realism would have resulted in more reasonable estimates of the area which the projects would likely irrigate, probable cost increases and the implied costs per hectare irrigated. This does not mean that the economists should have felt tied to the prevailing utilization rates and costs. Improvements proposed by USAID's package would permit some adjustment in those rates. Since the analysts were using internationally accepted methods and assumptions, they need not be faulted because those methods and assumptions are not working well in India. USAID's design process which allows little time to investigate field realities with survey methods, and the short-term consultant style of project appraisal are perhaps more to be questioned than those who conducted the engineering/economic analysis.

Summary of Cost and Area Actually Irrigated Estimates. For the Maharashtra Medium Irrigation Project the original estimated creation of 87,000 ha of CCA will probably be reduced to 50,000 to 60,000 ha because of estimated cost changes, and from 50,000 to 60,000 to about 30,000 to 35,000 ha due to over-optimism on utilization rates under likely OM&M conditions. Therefore, from the information now available we estimate

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[13]Case study of Binayka 1 Catchment, Office of the Development Commission, C.A.D. Chambal, Kota, Rajasthan, September 1980.

that the area that actually will be irrigated will be only about one-third of the originally estimated area with the same total investment. Thus, costs per actually irrigated hectare are likely to be more than three times those projected in the Project Paper.

Some of the cost increases are due to simple inflation, which must be accounted for by bringing costs and benefits into constant monetary units, which USAID did and we have tried to do in our assessment. There is, however, another important problem created by inflation which is not properly accounted for by such a simple adjustment. When costs escalate after initial investments have been made, the budget allocations of local funds may be insufficient and further construction is delayed awaiting additional budget allocations. Even if new budget provisions are made overcoming the deficit caused by inflation, the delay may cause a significant deterioration in the benefit/cost results due to a longer waiting period before benefits flow. The delays which now appear to be imminent in the USAID projects are hardly exceptions to the general pattern. A recent study examined cost escalation and delay in completion on 527 irrigation projects and emphasized the interaction between the two factors:

> The Group felt that escalation in costs . . . resulted in postponement of the completion of the project due to the inability of the States to provide additional funds commensurate with the rise in costs. The analysis . . . showed that as against the original completing period of 5 to 10 years, the revised targets covered 12 to 20 years.[14]

Thus, the effect on the benefit cost computations from delayed realization of benefits could more than negatively offset any positive adjustments which may come from more careful attempts to account for inflation in costs and benefits.

From the scanty data we have reviewed it appears that the Rajasthan project would have somewhat better results and the Maharashtra Minor project somewhat worse than the above estimates. However, we have no reason to think the average pattern for the USAID projects will be substantially different from that presented above, except possibly as described below.

A benefit/cost analysis appropriately deals with both benefits and costs. The estimated USAID benefits appear to be 30 to 50 percent higher that appropriately adjusted results in the 800 farm survey. There are two reasons for thinking that the USAID projects may have a fighting chance of reaching these benefit estimates. The USAID design package has some important elements in it not used in the surveyed commands. Secondly, the survey failed to measure "external" and off-farm benefits

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[14] N. Pant, "Major and Medium Irrigation Projects: Analysis of Cost Escalation and Delay in Completion." In: Economic and Political Weekly, June 1982, p. A-36.

from irrigation. It is not unreasonable to assume that these two factors might make up the 30 to 50 percent difference. On the one hand, USAID projects appear to have a reasonable chance of reaching per hectare benefit estimates, but on the other, appear to have no chance of staying within cost estimates.

Cost benefit analysis is most useful as a comparison between investment alternatives. It should not be viewed solely as a project "hurdle," but rather to assist project designers and decision-makers in comparing investment alternatives. Investment alternatives include not only USAID's investment alternatives, but also the investment alternatives which face USAID's ultimate clients, the poor and small farmers. Current evidence suggests that small farmers in India have better alternative investments which they could and probably would make if they had $1,000, for example. In the Deccan Plain where USAID's projects are concentrated, one of these alternative investments could be a dug well if within the hydrological limitations of the aquifer (see Annex II). Current evidence suggests that a dug well investment would return about 30 to 50 percent per annum, and other more general investments about 12 percent.

If USAID and GOI and the States invest in an irrigation project with below a 12 percent actual realized ERR, poor and small farmers could be the losers, for example, if the alternative were the dug well investment at 30 to 50 percent ERR. This is only relevant to USAID if groundwater investment is a viable option for USAID financing. It is not USAID, nor the GOI, nor the States that are the losers in irrigation investments with low ERRs; in the final analysis poor and small farmers are the losers.

Most of the USAID individual subprojects have not yet been designed and selected, and very few are under construction. Therefore, it appears important that the design and selection process which is now just beginning be reexamined and reoriented to assure that AID-funded subprojects meet or exceed a more realistic ERR target than that which results from current accepted procedures. In Chapter V the Team suggests ways which should help to accomplish this.

Implications of This Interim Assessment. It is important that these interim assessment findings not be misused or misinterpreted. The data we have used are a mix of assumptions about cost increases, field survey data on already completed projects which are not USAID-funded, and assumptions about "average" utilization (which is itself a much debated topic among competent analysts). While we feel these data and assumptions provide a useful hindsight based on improved information, it would be unfair to pit this version "against" the design exercise which was itself conducted according to internationally accepted professional methods and standards.

It would be inaccurate to suggest that the analysis presented here constitutes an "evaluation" in the way that word is normally and

correctly used in AID. The projects are not evaluated here, they could not be, they have not been constructed. What is evaluated here is the planning and appraisal process itself. These projects meet the cost benefit requirements of USAID in that the estimated ERR (as determined by internationally accepted methods) was reasonably above the 12 percent required.

Although it now appears that the procedures used will give inaccurate project[illegible] in India (and particularly in the Deccan Plain), this should not be [illegible]d to suggest that the projects do not comply with AID procedure or B/C standards. Those standards are based on a number (estimated ERR or IRR) to be derived by an accepted procedure, and that standard appears to have been met in the case of USAID's/GOI irrigation portfolio.

The Team suggests that for future planning a more realistic procedure given OM&M conditions likely to exist be used to better estimate the "realistic" ERR computations as contrasted from the "accepted design ERR." AID procedures, as we understand them, deal as they must with "design ERRs." If the Agency were to decide to adopt an economic standard different from the internationally accepted one, that would require a change in the standard procedures. In a sense, we are critical of USAID in this matter.

In summary, from our review the projects appear to meet the 12 percent projected ERR standard as required by the USAID project criteria. However, actual field performance could be improved by using a different design process. The improved methods would involve added use of field data from existing systems to arrive at more realistic estimates of benefits, costs, completion schedules and utilization rates. This is a question of improving a process, not of meeting a prescribed standard.

Rural Equity and Employment[15]

The project papers outline equity objectives at two levels: to increase irrigation on small farms; and to increase the incomes of the small farmers. One could add a third level: closing the relative gap between the rich and poor.

The target for increasing incomes of the small farmers in the Maharashtra Medium Irrigation Project is to increase it by 2.5-fold. Estimates from 800 farm surveys mentioned earlier suggest that small and marginal farmers increased their income through irrigation by 1.12 times. It would appear that if the USAID package of design procedures and technical assistance works as planned it is not unreasonable to expect USAID projects to reach their target of a 2.5-fold increase in small farm incomes.

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[15]This is a summary of a longer paper on the same topic presented in Appendix E.

Data for Maharashtra[16] indicate that small farmers have been able to capture a larger share of irrigation water than an even distribution of irrigation by land area would have given them. Small farms (0 to 3 ha) irrigate 11.7 percent of their land, 3 to 10 ha farms 7.9 percent and large farms 5.7 percent. Therefore, it appears likely that small farmers in USAID-funded irrigation projects would be able to get a larger share of irrigated area than their land areas would entitle them to. However, our study also shows farmers will not be able to even get their fair area share of reliable water (that is, regularly available well water) nor of water for multiple season irrigation. Thus, the profitability of irrigation which depends less on low value crops irrigated once than on higher value crops requiring dependable and multiple season irrigations, are not being captured fairly by small farmers in surface irrigation commands.

Our studies show that a higher proportion of small farms (3 ha or smaller), more than twice the proportion of large farms (10 ha and larger) in Maharashtra receive canal irrigation; but the reverse is true for well irrigation where the proportion of small farmers with wells is less than half the proportion of large farmers who have them. For canals the pattern is the result of public policy. For wells it is the result of different capacities to invest, and of hydrological limitations. The present USAID irrigation portfolio will have little impact on this inequitable access to reliable and highly profitable well water. It is the profitable well water that larger farmers are interested in. To give small farmers access to relatively unreliable canal water in the name of equity is mostly an illusion.

The last measure of equity is the relative income position of the rich and poor, or between large and small farmers. While small farm incomes are likely to reach USAID targets, the gap between rich and poor will probably widen as a result of irrigation in USAID-funded commands as it did in the ID projects included in the 800-farm survey cited above. The more important problem from the equity point of view is that the poorest rural families are not small farmers, but rather the landless. The connection between the landless and irrigation is more fully discussed in the background paper for Chapter IV presented in Appendix C.

Even if one ignores the above discussion and assumes that canal irrigation is creating substantial equity, the deficiencies identified by the discussion in the preceding section on Probable Productivity and Economic Impacts would make that finding largely moot. The Irrigation Department is quick to point out that equity needs no economic justification; spreading the water, they say, is justified on other grounds. When one explores what those other grounds are they inevitably return to income, employment and nutritional benefits to the poor. They seldom realize that they have simply come full circle. Equity is

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[16] S. Daines and J.R. Pawar, "Statistical Profile of Agriculture, Nutrition and Development Trends in India: A Case Study of Maharashtra State," Logan, Utah, 1984, 38 p.

benefiting the poor, that is its essence. To argue for "spreading" water through surface systems on equity grounds requires considering the degree to which this benefits the poor, and this is where the argument fails.

Irrigation Department Linkages With Other Institutions

Through the USAID irrigation projects the Ministry of Irrigation and State IDs are linking with other important institutions. However, especially in the case of the IDs the set of institutions presently being involved is overly narrow. Important groups are missing from the potential network; in particular, technical and socioeconomic researchers, management specialists and resource groups experienced in farmer organizing. Moreover, the mode of interaction to be promoted needs to be a networking one rather than coordination of others by the IDs or a mere subcontracting of jobs to be done.

The cases of Himachal Pradesh and Madhya Pradesh both illustrate the problem of missing key institutions. In each State an overall policy level committee was formed that links the ID with other important institutions. The set of institutions in Himachal Pradesh is larger because several government agencies other than Irrigation are involved in project implementation, i.e., the Agriculture, Rural Develpment and Horticulture Departments. In Madhya Pradesh only Agriculture and Finance are included in the Minor Irrigation Committee. However, in both cases there are important missing partners. For example, neither of these committees include institutions that are experienced in analyzing management policies and procedures. But including such specialists is of fundamental importance because one reason for poor irrigation project performance may be the structure and procedures of the irrigation agency itself. Its procedures for planning, budgeting, project implementation, staff development, etc., may be contributing to poor irrigation performance and preclude the attainment of objectives such as greater user involvement or the mobilization of local resources.

Unless new institutions relevant to the broader interpretation of irrigation development implicit in the USAID irrigation projects are brought into the network -- through the various committees, new cells, etc. -- the projects are likely to result in more of the same rather than in increased institutional capacity for irrigation development.

Moreover, the form of interaction between each ID and the organizations to which it is related is of significance. The aim is to create a network of institutions concerned with irrigation development, each of which contributes its own expertise and perspective to the issues. This cannot be achieved if the ID is the "coordinator" of the other institutions. Nor will it occur if the ID merely enters into subcontracts with these groups to perform certain tasks.

USAID's Relationship with Other Donors

The principal donors with which USAID has some fairly close dialogue about irrigation development are the World Bank and the Ford Foundation. However, at present the dialogue is more or less on an ad hoc professional and personal level rather than formally in joint projects. This could be the most desirable mode.

The World Bank's irrigation portfolio is about ten times as large as USAID's and the Ford Foundation is considerably less than one-tenth of USAID's. Most of the Bank's portfolio is in hardware investments, while most of Ford's is in special studies and other software, while USAID's portfolio is fairly evenly split with about 75 percent in hardware and 25 percent in software. In spite of the obvious differences, all three donors have a common interest in and devote most of their attention to improving the performance of public and community irrigation systems.

During its study activities the Team had considerable contact with the other two donors and found a number of areas of complementary interest and ad hoc collaborative effort. For example, the World Bank sought USAID's critique and council on their latest project proposal for improving the main system management of medium and major projects.

One of the Teams' final debriefing activities was a joint session with the top India office administrators and professionals from all three donors. We led the discussion in such a way as to draw out the Bank's and Ford's opinion in the areas of our main findings without first disclosing our opinions. To our surprise, we all three (rather independently) have reached about the same conclusion as to the most promising areas and activities for donor intervention in the Indian irrigation tapestry.

Conjunctive Use and Groundwater Development

The first phase of USAID's involvement in irrigation in India was aimed directly at groundwater development through credit for financing wells and complementary financing of rural electrification. By comparison with the current irrigation portfolio and its probable direct impact on small farmers and ERR, the groundwater phase was an extraordinary success. Approximately 63 percent of the total benefits went to small farms, which actually reversed the inequitable distribution of reliable water which favors the large farmers in canal irrigation projects. The benefits and costs were also dramatically different from the current canal irrigation phase, as the ERRs actually realized (as contrasted to "projected") were in the range of 35 percent.

The two Maharashtra and the Madhya Pradesh projects require that specific plans including the development of credit packages for well

development in subprojects be undertaken by the IDs. The design studies for Maharashtra Medium Project suggested that training courses be held on conjunctive development of groundwater and that water balance studies and conjunctive use demonstrations be conducted on at least two subprojects. We think, however, that these activities will have little impact on conjunctive use and groundwater development, at least in the short-term. In Chapter V we present possible ways in which USAID's irrigation program could be reoriented to capture some of the very considerable benefits which USAID's groundwater program of financing development credits to the ARDC achieved.

Extensive and Intensive System Design

There are many different ways to use the terms extensive and intensive with reference to canal irrigation systems. This topic is discussed in considerable detail in Appendix C. Project irrigation intensity is the ratio of the area of crops irrigated divided by the cultivable command area. Seasonal design intensities for medium and minor projects in USAID's clientele States are low, in the range of 25 to 85 percent. USAID's current projects will have some impact on increasing the project design intensities through improved design criteria, but this will only eliminate the design gap part of the utilization problem at best.

The USAID subproject qualification requirement for more rigorous analysis of water budgets to the field level reduces the estimates of irrigated area that could be covered with a particular water supply. In order still to meet economic criteria one design option would be to reduce the command area and thus increase irrigation intensity. This does not seem to be happening in actual subproject planning and design. Reservoir size has been increased and lining has been specified, but command areas have not substantially changed and irrigation intensities, if anything, have been reduced. These changes and the addition of chak development, along with increasing costs, has substantially increased estimated real per hectare investment cost.

Actually, project intensities are seldom achieved under present designs; in fact, based on a study used in the Maharashtra Medium Irrigation Project Paper, they were only 50 to 75 percent of those planned. There is reason to hope that the design utilization targets under the USAID-supported subprojects will be realized. This would have the effect of increasing actual realized intensities by 50 to 100 percent over present ones.

Moving toward more intensive agriculture on individual farms, i.e., increasing fallow and adding higher value crops with higher applications of water (increased farm water application intensity) is another option if water supplies are reliable. This would reduce project intensity and vice versa. Farm water application intensity is expressed as depth of water applied to a field in a season. Suppose CCA is 1,000 ha, that irrigation allowance is 40 cm and project intensity is 50 percent, meaning that 500 ha is to be irrigated at a field intensity

of 40 cm. Suppose the average farm is 5 ha. Instead of irrigating 2.5 ha, farmers choose to irrigate 2.0 ha, going for higher yields. This raises the field intensity to 50 cm and lowers the project intensity to 40 percent.

A land ownership-based water allocation would permit each farmer to reduce the area of his farm irrigated and increase the amount applied per hectare. If cash crop markets are available, farmers will probably move toward more intensive field applications on smaller areas. For traditional food grains the farmer probably would move toward more extensive field applications. Whether or not he would sow traditional varieties or shift to HYVs would likely depend on his access to other inputs such as production, credit, fertilizer and labor, plus his perception of the reliability of irrigation deliveries. Development of conjunctive use of groundwater would open up greater opportunities for cash crops including perennials with likely shifts toward more intensive field applications. High technology such as trickle irrigation would reduce field applications because of its high efficiency, but certainly would represent a more intensive form of agricultural practice.

If a relatively small amount of water is to be used to irrigate a large area, the system is called "extensive." The fact that a large system of canals will be needed to take small quantities of water to distant areas increases the cost per potential unit area irrigated. When powerful farmers (either in the head reaches or elsewhere) confiscate more than their share of water, and when greater than anticipated canal seepage losses occur, the quantity of water actually delivered to distant areas is even lower. With insufficient water, distribution to the many potential users becomes so erratic that small farmers find it difficult to use such water profitably, so the demand may even be less than the unreliable supply.

All of the specific internal dynamics of the process by which extensive systems adjust and become more intensive are really not known at this time, but the fact that they do is in evidence. Unfortunately, there are not sufficient data to analyze the complex socioeconomics of the causes contributing to under-utilization. Furthermore, studies of the full socioeconomic impacts of various levels of intensity during the planning stage are not available. Perhaps it can be demonstrated that by increasing project intensity more land can be irrigated, giving more and higher value production and more employment with the same total investment. USAID could make a major contribution by simply supporting such data gathering and analysis efforts. This is not the same as a "Diagnostic Analysis." We found them to be as void of this kind of data as the more general literature.

Extending the cultivable command area without extending the actual irrigated area is directly related to the high cost of systems per actual irrigated area, and hence a major part of the B/C problem. In Chapter V specific ways are outlined in which the subprojects not yet commenced (close to 90 percent of the portfolio) could be redesigned to reduce their costs through more intensive designs.

CHAPTER IV

CONSTRAINTS AND ASSUMPTIONS GOVERNING ALTERNATIVE FUTURES

This chapter deals with the constraints and assumptions governing USAID's future alternatives. We have divided the material into five subsections: GOI Policy and Priorities; USAID Budgetary Levels; Possible Long- and Short-Term Technical Assistance; USAID Policies and Priorities; and USAID Project Design Process. We depended on our insights and discussions with the GOI and USAID to develop this material.

GOI Policy and Priorities

The GOI policies for bilateral assistance and irrigation create the environment in which USAID assistance operates. These policies both enable and constrain the options USAID faces for its future program. The purpose of this section is to outline briefly a series of assumptions about the GOI policy framework to guide planning of future programs.

Policies on Bilateral Assistance

The policies of the GOI related to the role of bilateral, and particularly U.S. bilateral assistance, are the framework which both enable and govern alternative futures for USAID's irrigation program. Among the most important apparent GOI positions in this regard is holding a low profile of U.S. expatriate presence in India and the parallel relative lack of interest in serious general irrigation policy dialogue. The issue of the limited possibilities for long-term expatriate technical assistance is discussed below. A fuller examination of the policy dialogue issue has already been covered in Chapter III.

Groundwater Development Policy

For the most part, in accordance with GOI policy, groundwater has been developed in the private sector. The role of the public sector in monitoring groundwater supplies under the Central Groundwater Board is well established and effective. Substantial capital support is provided for credits under the banking system and directly from the State Agriculture Departments by Plan funds allocated by the Center and from State appropriations. Actual construction and operation of wells by public agencies is, on the whole, ad hoc. There are State tubewell projects, mostly by the Ganges and Indus alluvial plains, particularly in Uttar Pradesh. There is a growing awareness that the most important part of India's irrigation future lies in groundwater, as discussed in detail in Appendix D. Questions of the role of the public (and private) sector in future groundwater development are largely unresolved at this point.

The fluidity of groundwater policy, rather than being a constraint on USAID's future involvement in irrigation, presents important opportunities for policy dialogue. Such dialogue is much more difficult in canal irrigation because of the very large momentum and sensitivity of GOI policy there. Technology development and its institutionalization is mixed. Some advanced pumping technology is available, but is limited in use and application to Indian conditions. The fluidity of groundwater policy, compared to surface, provides opportunities for USAID technology transfer and institutional development in an emerging and perhaps more flexible institutional environment.

Extensive and Protective Irrigation Policy

Our evaluation of the current irrigation portfolio raises some concerns about the economic and equity potentials of the subprojects so far submitted by the GOI for USAID funding. There are possibilities to do further redesign and improve proposed subprojects. This must be done before USAID funding is committed through more careful subproject appraisal and review. In many cases GOI policies appear to emphasize "protective" or "extensive" canal irrigation projects that constrain the productivity and equity impact of surface irrigation systems (as discussed earlier). In designing future projects USAID should be more aware of the implication of these policies and realistic in appraising how much they can be changed. These policy issues are rather complex and are outlined in the background paper for this section which is presented in Appendix C.

We suggest that the GOI "protective" and "extensive" policies make it very difficult to meet AID economic criteria using a realistic B/C analysis, as discussed in Chapter III. This suggests that when "extensive" canal irrigation projects are analyzed using USAID economic criteria the number of qualifying subprojects will be so low that large USAID construction projects may not be viable options in the future.

Policy on Center and State USAID Relations

An important area of GOI policy which governs USAID's future alternatives in irrigation is the relationship between the Center and the States. Irrigation policy (with some important exceptions) is essentially a State matter. Therefore, the best opportunities for technology transfer, policy dialogue, institutional development and involvement with the private sector are at the State level. Government of India policy which requires AID to enter through the Center governs the degree to which USAID assistance efforts can focus usefully at the State level. There may also be preferences at the Center for directing USAID assistance to certain States and away from others.

While such GOI policies govern USAID's future, they are not entirely clear at present. We suggest that they will only emerge as specific project possibilities are explored and USAID approaches to institutional mechanisms are developed.

USAID Budgetary Levels

USAID budgetary levels should not present any serious constraints on future irrigation alternatives if overall levels to India are more or less maintained at current levels. If the share of irrigation in the portfolio remains relatively constant, there may be somewhat more funding than required for the project possibilities which the Team currently envisions. These are very rough and broad brush views, as they must necessarily be for general strategy. However, as project possibilities mature the perspective could easily change.

Possible Long- and Short-Term Technical Assistance

Perhaps the most important constraint to alternative futures for USAID's irrigation program in India relates to expatriate long-term techical assistance. Simply stated, the GOI seems to want to limit the number of U.S. expatriates (especially professionals involved in long-term technical assistance). This is not an unreasonable view given the high cost of U.S. technical assistance. The policy, however, affects not only the USAID process, but also the substance of projects. With the IM&T project now approved it appears unlikely that other large expatriate TA projects will be feasible in the near future. This has implications not only for project implementation, but also for project development and evaluation.

The USAID alternatives in this area are limited and seem to point in the direction of the development of a rather unique (for AID) approach to project development, implementation and evaluation. That is the intensive use of local hire or consultant professionals. This is possible because India has the third largest number of trained professionals of all types of any country in the world. Only the U.S. and USSR have larger total numbers. The correspondingly large number of world class and lesser but competent institutions opens as yet a relatively untapped potential for such an AID approach in India, which is distinct from other LDCs.

It may be fair to characterize this as a less interventionist and more mature approach, but perhaps it will be a slower one. With the right mix of Indian nationals and expatriates it could be faster. Under this approach USAID direct-hire and short-term expatriate personnel could have a lower profile in the development, implementation and evaluation of projects. USAID could seek Indian institutional partners to undertake the bulk of this work. USAID long-term direct-hire and expatriate short-term personnel would direct and evaluate the efforts of these local partners, but would shift the large majority of the project work to them.

For such an approach there needs to be longer term continuity with both AID direct-hire and world class institutions and invidividuals from the U.S. Short-term expatriates with long-term institutional linkages and long-term repeat visits could provide technical continuity and infusion of outside ideas. Avoiding single visit short-term consultants should also help in building credibility with GOI.

This alternative stands on its own merits, but there is a complementary one also. A major part of the difficulty stems from AID's own policy. If AID would provide technical assistance in kind rather than forcing it through host country budgets in competition with Indian professionals, the problem would reduce to one of building mutual confidence, which has been very promising. Other donors, UNDP, FAO and Ford, operating in this mode have been more successful.

An alternative configuration of direct-hire personnel may be possible if the USAID assistance were to shift from a strictly project approach to a broader "program" focus. A program approach would reduce the day-to-day burdens of project implementation and monitoring and open opportunities for a better planned and more orderly technical dialogue role for direct-hire personnel.

USAID Policies and Priorities

The policies and priorities for USAID's India program center on poverty and population. The contribution of irrigation to agricultural development and the eradication of rural poverty in India is outlined in Chapter I. Within the poverty objective, USAID's priorities relate to technology transfer, institutional development, policy dialogue and private sector development.

From the point of view of irrigation and poverty, most of India may be roughly divided into four agro-hydrological regions. These are: the developed North (Rajasthan, Punjab-Haryana and Western Uttar Pradesh); East India (East Uttar Pradesh, Bihar, West Bengal and Orissa); the Deccan (Madhya Pradesh, Maharashtra, Karnataka and West Andhra); and the South (East Andhra, Tamil Nadu and Kerala).

India's severe poverty is concentrated in the East. Given AID's poverty objective, involvement in this geographical area seems logical; however, current projects are concentrated in the Deccan, with some minor involvement in the South. The untapped potential of irrigation development (particularly groundwater) is in the Eastern section of the country, but USAID has little experience and insufficient information at present to embark on project development there. The Eastern rivers are large, flooding of the flat plains is severe and monsoon precipitation is much higher and possibly more intense. The impact of severe floods on groundwater development infrastructure is not understood, for example. There may be a much greater need for considering irrigation in the context of overall water resources development plans than for the small

watersheds, rolling or hilly terrains and more scanty precipitation encounted under USAID's present medium and minor projects. Institutional arrangements and socio-political goals are different also, and these factors should be better understood and evaluated before entering a new geographical area.

How much effort will be needed to explore these possibilities is not known. There may well be good opportunities where a groundwater development program, for example, can be largely isolated from the larger regional hydrological problems. The hydrological situation is similar to Bangladesh where AID-supported well development is proceeding effectively. USAID should examine the approach being used in that country as a possible basis for developing a strategy for the East.

The foregoing discussion raises the issue of irrigation strategy in the present States. With the expiration of present AID project assistance completion dates, the two medium irrigation projects will be left with largely incompleted subprojects. The Rajasthan project did not include chak development as a project-financed activity. A later PID for a separate command area development project was submitted, but further planning has been deferred. In Maharashtra none of the medium projects were planned for completion within the financing and five-year time limits of the project and GOI/GOM covenanted to finish them at agreed-upon standards at their cost, leaving open the question of USAID participation in a second phase of what is basically a ten-year project. As mentioned earlier, for the minor projects, many of the subprojects will essentially be completed within the time and financial limits of USAID's involvement.

An important question to be answered is whether or not stricter appraisal and monitoring as outlined in Chapter V has a reasonable prospect for closing the utilization gap and improving the cost effectiveness of subprojects. This is beside the point, however, unless there is improved OM&M. To achieve a set of effective operating medium irrigation systems in one or more of these States is an important goal, especially if these can be locked into improved institutional arrangements; but, including an OM&M phase will require a long-term effort -- at least another five to ten years. Likewise, if real progress can be made toward the Himachal Pradesh objective of developing a real framework of multi-agency, community and private sector teamwork at reasonable cost, continued support may be merited there. The eventual utility of the IM&T project depends upon what structural rearrangements, e.g., defining multi-agency responsibility status of an OM&M cadre with full admission of other disciplines, etc., the States and GOI will put in place so that training benefits may be indeed captured. These questions cannot be answered now, but will require in-depth evaluations as the projects mature.

AID Commitment to Long-Term Involvement

Working in a new mode in India dependent on greater involvement of local institutional partners would require much longer lead times in

project development and implementation. It may even require a reorientation of the perceived difference between projects and programs. Thus, a long-term USAID approach based on three phases of involvement may be more appropriate in India than elsewhere. The three phases we suggest are:

- Examination of existing field experience and analysis of apparently viable irrigation development "models" in one or more of three agroclimatic regimes (Deccan, East and South);
- Development and implementation of specific "pilot" or demonstration projects in a single State for each "regime" to test these alternative models; and
- An attempt to use USAID funds as core or complementary funds to replicate the model, with larger contributions from other donors in other States inside the relevant regimes.

USAID assistance in this mode would be seen as a gradually widening circle of impacts based on field tested and proven irrigation "development models" appropriate for the major agro-hydrological regimes in India.

This is a rather long-term approach and would require a long-term USAID and GOI commitment. The realities of relatively short cycle times for both USAID staff and USAID policy make this kind of long-term commitment difficult. On the other hand, the realities of the Indian situation strongly suggest such an approach.

At this time USAID may be viewed as having usefully concentrated its efforts in developing experience and testing viable canal irrigation models in one of these three regimes, the Deccan. The Team's recommendations in Chapter V involve further refinement of the current USAID "Irrigation Department Model" in the Deccan. In Chapter VI we recommend the development of two new models or approaches in the Deccan, "Commercial/Groundwater and "Local Sector." USAID's IM&T project involvement in Tamil Nadu could be used to develop one (or more) irrigation project models for the South over the next two years. These could become the bases of future projects there during the coming decade. There is no current USAID involvement in the East which could provide the basis for the development of viable irrigation project models there.

USAID Project Design Process

In discussions with USAID techical professionals it became apparent that there is a need to examine the conventional Agency approach to developing projects. Some think that the Agency structure and project mentality also crete severe constraints in evolving good irrigation management (IM) projects and building those discrete projects into a

workable strategy. Given the fact that IM requires definitive focus on human resource and institutional development, the typical project design approach and the "blueprint mentality" do not allow the flexibility required. This hinders evolving a workable strategy and building in long-term learning processes. The resulting set of projects creates neither a comprehensive strategy nor program, but merely a collection of separate projects. These have too few viable linkages among themselves as well as between the creation of the irrigation infrastructure and management of it.

There are several major constraints in the current project design process. To begin with, the project develpment time frame is very short, but what seems to be needed is a series of useful studies and other activities to carefully prepare the environment for the new innovations (projects which fit into a program). Typically, at the project paper (PP) stage consultants rush around the country, often without adequate Mission or host country participation, to put together ideas and information. The time frame for the development of most projects is usually unrealistically short. Furthermore, the rush is still on to quickly negotiate the project without realizing that where institutional and human resource components are involved, few host country officials quite realize what they will be getting. It appears that the project negotiations take place at high levels where details seem to get lost in both the GOI and USAID. It is virtually impossible for these officials to be fully informed of all the critical operational details of the projects which are being negotiated.

In reality, the project agreements we reviewed do not contain sufficient detail to provide guidance or controls for assuring that India lives up to the agreements made. Including this level of detail in a document to be reviewed at highest GOI levels would be very difficult. USAID might explore including referencing to the Project Paper and Annexes and including more detail in its "letters of implementation." Once projects are signed there seems to be a period of relaxation by USAID, GOI and the State IDs. Possibly this is due to the fact that the reward system is focused primarily on developing projects rather than implementing them.

It appears that the PPs are written primarily for the AID/W audience rather than India. In order to assure approval, the latest mandates, emphases, etc. at times seem to be built into some projects without adequate investigation or preparation of the GOI. Moreover, it appears that AID/W is moving further toward the software dimensions of IM such as training, institution building, action research and special studies and community organizations. However, AID/W is giving insufficient attention to the need for more staff suport for the successful implementation of these components.

Some possible actions which will counter the above constraints are to: utilize the centrally funded Water Management Synthesis Project to implement activities for preparing the environment at the Center and in

the States prior to PP development; utilize short-term TA who have Indian experience and/or long-term commitments to India plus more local staff; focus more on securing local institutional support during the design process itself; provide ample lead-time 12 months or more, with continuous leadership and coordination of the technical design by a single experienced person; provide stronger loan and grant agreements; negotiate harder to include the necessary items for successful implementation; monitor and enforce the project agreements more firmly; and build in a stronger in-house or contracted unit for the project design and appraisal process. Rigorous appraisal by USAID seems to be missing when it comes to the choice of individual irrigation subprojects. The project design process might well be improved if the Agency, both in Washington and the Mission, utilized some of its own technical professionals along with consultants. Finally, no matter how well planned and constructed, without improved OM&M utilization, targets will not be met. OM&M is not included in AID's present portfolio (except for training), so this is a consideration which needs to be factored into USAID's strategy.

CHAPTER V

SOCIO-TECHNICAL OPTIONS FOR FUTURE USAID ACTIVITIES IN THE CURRENT IRRIGATION SECTOR PROGRAM

The current USAID irrigation program is faced with three major issue areas: disappointing B/C realities stemming from higher than expected construction costs for systems which will serve less irrigated area than projected; chak size questions which relate to manageability and maintainability by the IDs above the outlet and by farmers below it; and a whole set of institutional questions resulting from requiring IDs, ADs and other State agencies to take on new roles and cooperate in new working relationships with other institutions as well as their farmer clients.

The focus of the Mission's software aspects of the portfolio is below the chak outlet, but this is only part of the irrigation management (IM) picture. While the Team does not feel below the outlet issues are of a lesser importance, we do recommend giving more attention to the issues relative to the analysis of benefits and costs and to designing and managing systems to deliver equitable, reliable and timely flows and discharges throughout the entire system.

Irrigation Technology Options

The current program in one way or another contains most any practical technical option we can think of. Thus, the most important consideration is selecting the set of technical options which the Mission, GOI and the States should concentrate on. We recommend focusing on the following:

1. First of all, for the new individual medium and minor subprojects (of each State project), concentrate on assessing and monitoring throughout the planning, design, construction and commissioning stages;

2. Conduct water budget studies and concentrate on the reliabiity and timeliness of water deliveries and economic realities of the entire system (with limited analysis below the outlet) when appraising existing systems for rehabilitation and/or management improvements. Furthermore, appraisals carried out for the purpose of gathering information (not training) should be done as rapidly as possible and should offer recommendations which are practical within the realm of socioeconomic potentialities;

3. Select technologies and designs (including pipe as well as lined or unlined channels) for the main distribution networks

which are practical to operate, manage and maintain. The most important challenge is to provide visibly equitable and reliable water deliveries at public outlets serving 20 to 100 ha chaks. By reliable, we mean consistent deliveries made in a timely nature to meet aggregate crop water requirements within each chak in view of the real-time crop, soil water storage and weather conditions;

4. Provide support for expert technical assistance (addressing both physical and social considerations) for laying out, obtaining right-of-ways and designing watercourses with the chaks below the public outlets;

5. Take a more pragmatic approach to the whole area of conjunctive use including both wells and return surface flows;

6. Direct more software resources and attention to managing the main system down to the public outlet; and

7. Pinpoint most training directly at the task oriented level (as opposed to the general educational level) to carry out the above.

Assessing and Monitoring (A&M)

The Mission's irrigation program is heavily oriented to the building of irrigation infrastructure with 75 percent of the assistance funds devoted to financing project construction. Furthermore, much of the "technology transfer" impact will be directly related to how well the planning, design, construction and commissioning is carried out (as discussed herein). The USAID project planners were well aware of this and called for upgrading planning and design criteria for the medium and minor subprojects. They also specified a number of special studies to test and improve these planning and design criteria.

Providing new criteria is not sufficient in itself, for obviously it must also be carefully applied. This takes a level of discipline which, in view of the past history, can hardly be expected without giving more serious attention to continuing project assessment and monitoring. Using economic criteria in the form of ERRs or B/Cs is the first step and must be based on careful assessment of the physical designs, cost analyses and probable direct irrigation benefits of each subproject.

The literature is full of frustrating examples of lack of commitment. A. Sundar[1] states it well when he says:

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[1] A. Sundar, "Modern Techniques for Management of Irrigation Systems: What Can They Do in the Absence of Commitment to Manage?" WAMANA, Vol. 4, No. 3, July 1984.

> Management Science has a set of tools and techniques for analyzing various management situations to aid decision making. Managerial decisions are made in the light of objectives of management. When there is not desire or commitment to manage irrigation systems, what is it that techiques can do. . .
>
> That we (India) are not concerned about it (management of irrigation) is shown by the fact that it requires foreign donor agencies to prod us to start training programs. When thousands of crores of rupees are being invested in irrigation projects, it requires a foreign donor agency to find a meager sum of a couple of million rupees to start action research in irrigation management, seminars and symposiums and a newsletter.
>
> Management is based on the premise that things can be done better, which in turn means that one wants better performance. In a socio-political situation where what is legitimate is what one can get away with, can there be any concern about public system performance? And if there is no desire to manage, what can management technique do?

The USAID program attempts to stimulate the necessary discipline (incentives) to manage the planning through commissioning of each subproject by improved planning and construction criteria with an estimated ERR of 12 percent. But to what effect? For we are now beginning to realize that subprojects can slip through present appraisal and monitoring procedures. These subprojects, if analyzed after commissioning, will be construed as economic disasters based on actual direct irrigation benefits.

This is also well recognized in the literature; for example, in the "Report of the Commission for Irrigation Utilization" commissioned by the Government of Andhra Pradesh (November 1982, p. 70), the Committee went so far as to recommend that:

> . . . As long as it is recognized that it is generally possible to construct irrigation schemes (particularly a surface irrigation scheme) at reasonable costs and irrigation would always be beneficial, bringing prosperity and happiness in the command area, the projects could be cleared on technical considerations and on the financial capacity of the State for investment without insisting upon any particular B/C. If this be done, the overall cost of projects is likely to come down as the irrigation network would then not be constructed over a much larger area than actually justified.

There is good reason to assume that the findings of the Commission represent a prevalent thought and action pattern within typical IDs, or why would the reported planning gaps (which averaged 30 percent in the above-mentioned report) be so large. Given this realization, is it worth trying to do anything about it? And if so, what can USAID do?

The Team feels that much good will be accomplished by tackling the problems of assessment and monitoring in a more effective fashion. First of all, this course will provide a way for meaningful dialogue with the GOI and IDs on this important issue. It will also provide needed incentives for improving the management of planning through commissioning activities. This should foster a more innovative search for reducing construction costs while at the same time increasing the actual irrigated agricultural production and subsequent flow of benefits. Finally, while we suspect it will not be feasible to obtain the ERRs which AID would like to have, it will certainly improve them. We also believe this will ultimately result in significantly improving the economics of many future projects. The present B/C analyses include only direct returns to farm income through increased production. From a technology point of view, we feel it would be appropriate to include also some probable levels of the anticipated indirect benefits in the overall B/C analysis of the subprojects. This could be reported separately if desired.

Implementing a Stronger A&M Program

We realize that the Mission is concerned with A&M. However, given the vast number of medium and minor subprojects in the USAID irrigation portfolio and the traditional attitudes of the IDs, a much more intense A&M program is required. To provide this we recommend adding one or two appropriately experienced (Civil/Irrigation Engineers, Resource Economists and Social Scientists) professionals to the Mission staff, and relying on local consulting firms to carry out the necessary field work under their supervision. Probably all mediums and a representative sample of one out of five minors should be subject to careful scrutiny.

First of all, in view of the large cost increases projected for the Maharashtra mediums, we recommend requesting a performance evaluation for the Sina Project at its current stage of development. To do this a local consulting firm should be contracted to:

- Review all the planning and design documents and assessment studies;
- See what is in the field;
- Look into why costs have gone up;
- Do a water budget study based on actual canal seepage tests;
- Analyze the physical capability of the system; and
- Recommend what is needed and what steps should be taken before commissioning (finishing) the subproject.

We feel the above is both reasonable and necessary for USAID as well as the GOI Ministry of Irrigation to learn from experience. Otherwise, how can we prevent the same from reoccurring many more times? A

reasonable argument for carrying out the performance evaluation can be centered on USAID's need for understanding or knowing: why costs are higher than anticipated; the anticipated design gap between the probable actual and initial appraisal irrigation potential; if and where more canal lining is needed than originally planned; and/or if the project could be improved by such changes as shortening the lengths of main canals. In general, USAID should probably avoid adding partly completed subprojects to its Project portfolio. The problems of replanning and reconstructing them to satisfy AID criteria could be very expensive and even quite intractable.

After the performance evaluation further study may be necessary in order to identify possibilities for improving performance by employing more innovative techniques than lining. For example, in certain reaches of the main canal it may be more effective to let the canal leak and provide wells to pick up the seepage, or there may be opportunities to pump seepage water which concentrates in the Sina River back to the canal or provide wells to augment flows in lower reaches.

A socioeconomic baseline study based on interviews with 180 farm families in nine villages has already been carried out by MPAU under the special study provisions of the project in the Sina Command Area. This, along with the above proposed performance evaluation, will provide the essential data base needed to monitor and evaluate the Sina Medium Project. It will also provide a first and very important step for the Mission to begin an in-depth evaluation of its India irrigation projects.

Practical Technologies

Ideally, we believe public irrigation systems should be designed and managed so that there is some tension (shortage) in the water supply throughout. Efficiency is encouraged by uniformly spreading the tension which transfers the shortage to each farmer.

The Thikaria Minor of the Gambhiri Project, which was diagnosed and rehabilitated using AID financial and technical assistance, is a good example of a creative design intervention. This minor canal is fully lined and serves about 800 ha through 18 relatively foolproof outlets (or turnouts) along its 5,100 m length. The flow from each outlet is proportioned to the land area of the chak it serves (from 20 to 65 ha). To determine if either the gate is not properly set or some group upstream has tampered with the minor to get extra water, each outlet has appropriate markings so that any farmer can immediately check for proper flow levels at all 18 outlets along the entire minor. The only responsibiity of the ID is to open the head gate and set the flow into the minor canal. This illustrates what we mean by selecting designs for the main distribution network which are practical for the IDs to operate.

The Thikaria Minor has two very important features. First of all, being lined, it is relatively difficult to tamper with, and secondly, the flow markings provide all farmers with easy (visible) access to

information on how the system is performing. In addition, the dimensions of all outlets should be made a matter of public record so that any farmer can measure them to determine if his or any other outlet has been tampered with.

The physical circumstances of the Gambhiri Project are favorable for this approach. The general land slopes are relatively steep, soils are stable and there is plenty of stone and gravel nearby which can be used in making low cost linings for the canals. Unfortunately, it is not practical to have lined minor canals running down relatively steep slopes in all projects. For example, lining canals in black cotton soils is difficult and very expensive, and in other areas suitable materials for constructing low cost linings may not be available. Therefore, other solutions for different site conditions must be worked out; and that, we believe, is an important role in USAID's challenge.

The Team feels that having assured reliable water supplies delivered in a timely manner to each chak is the important objective regardless of chak size. Furthermore, a management system which provides equitable distribution must be held in place automatically through a sense of fairness based on a common understanding of each farmer's rights to water and acceptance of the measure of control. This requires appropriate markings which indicate when the flow through tamperproof outlets is correct. Under the above circumstances, if water is perceived as being valuable, the farmers themselves can, and we believe will, exert considerable discipline in system operation.

It is well known that the greatest inequities within irrigated commands are those between the head and tail ends of the main canal networks. Therefore, we believe the most important issue in dealing with chak size is not what is most workable below the outlet, but to what size outlet can the IDs (with prodding from the chak groups singly or collectively) deliver the requisite reliable and visually equitable supplies of water. The size may vary, even along the same minor, because of topographic and sociological considerations. However, it is the average size, and consequently the numbers of adjustable gates and adjustments, that govern the level of ID management effort required for a given level of control.

The computer assisted system design and management program now available through the centrally funded Water Management Synthesis II Project should also be helpful for management purposes. Certain programs can be used to assist in selecting various designs and water delivery schedules.Others can be used to assist in managing canal deliveries and timing reservoir releases on a real-time hourly daily and/or monthly basis.

Assistance Below the Outlet

Before we can expect water to be carefully utilized (and this includes equitably as well as efficiently), farmers must perceive it to

be more valuable than its cost to them. The value of water is heavily dependent on the reliability and timeliness of deliveries as well as its abundance relative to requirements and to the economics of the potential irrigated cropping program.

It costs farmers to convey and apply water. The more efficiently they apply it or the further they must convey it, the more expensive it is for them. If farmers feel it has little or no value, policy makers or international donors may erroneously conclude there is a need not only to convey water to fields, but apply it free of charge. However, we believe that in USAID's project areas irrigation water, when reliably and timely delivered, is very valuable to farmers. Therefore, they will dedicate considerable effort to convey it to their fields and use it effectively.

We feel farmers need some technical, organizational and perhaps financial assistance (credit, subsidy) in developing the system below the outlet. However, rather than constructing the watercourses and field channels, we recommend trying (at least on a few pilot schemes) the following approach. First, provide support for expert technical assistance (including both physical and social considerations) for laying out, obtaining right-of-ways and designing watercourses and field channels. At the same time, help organize the farmers to construct the channels, giving direct Irrigation or Agriculture Department assistance with the construction of structures such as drops and division boxes, etc.

If compensation to the farmers for constructing the watercourses is called for, one possibility would be to give them free water for three or so years. Another possibility might be to pay them as if they were subcontractors, with only one-third of the payment made upon completion and one-third at the end of each of the next two irrigation seasons, providing they keep the systems in full operation, etc.

Having farmers more involved in the planning and construction process should speed up work schedules and help get the farmers organized and more committed to their own system. In order to properly locate the chak boundaries and select the canal outlet positions and discharge rates to serve each chak, the AD or ID is already obliged to carefully survey the whole command area and locate the watercourses. However, the farmers would review watercourse locations and handle completing negotiations for rights-of-way and maintaining construction schedules which are very time consuming activities for the ID. Furthermore, we believe that being involved in developing their own systems is important in itself, as it will give the farmers a sense of ownership in it. Obviously, farmer involvement will not happen without some outside help. We feel that neither IDs nor ADs are particularly qualified to perform this function, and suggest mobilizing other institutions for this purpose.

Conjunctive Use

The Team believes USAID should try to generate a more pragmatic approach than is now used to the whole area of conjunctive use, including

both wells and return surface flows. Tradeoffs should be considered between lining and pumping. In certain situations in some areas it may be better to let the main canal seepage recharge wells and not try to deliver water through outlets. Money which would otherwise be invested in lining and minors could be used for well construction.

Seepage flows possibly augmented by direct releases to natural rivers or drains might be lifted efficiently and effectively to serve specific isolated areas. Deprived tail end areas could very possibly be better served by wells than by trying to improve canal performance. Another interesting possibility is to use canal water exclusively in rabi, which would in effect save the groundwater for the summer season, and possibly a couple of critical irrigations during kharif.

The point we wish to make is that there are a number of possibilities which should be considered to more pragmatically use and perhaps even subsidize reuse and conjunctive use. Given the high value placed on groundwater because it is nearly under the full control of the farmers who have access to wells, USAID should focus more attention on it. In Chapter VI we make some suggestions on how this might be approached.

Main Systems Management

There is opportunity to work with main system management in the "Irrigation Management Action Studies" (Action Research) part of the IM&T Project and in the development of curricula for in-service trainng and for universities under this same project. These opportunities to balance the software program should be exploited by USAID. The Team also recommends diverting some resources from the construction projects more directly to operational and management activities. The Maharashtra Minor Project includes support for some computer assisted management activities. We suggest that these activities be extended to two or three selected medium irrigation systems and some longer term (two or three years) assistance using the current project funds. What the Team seeks is a balanced program of software for all physical components of the system from farmers' fields to the reservoir and institutional components from the farmers and their organizations up through the irrigation agencies.

Institutional and Farmer Organization Options

This section addresses the general implementation of institutional development activities and the more specific needs for understanding and developing community irrigation management.

Implementing Institutional Development Activities

Many of the project activities associated with institutional development, such as training, special studies, action research and

organizing water user groups, relate to identifying and testing new approaches to irrigation development by the IDs, ADs and associated institutions. While a number of useful institutional innovations are under way, there is much more to be done. The major problems have been identified in Chapter III and are related to IDs assuming too many of the institutional development activities themselves and failing to develop a network of resource organizations to work with them. This problem is exacerbated by the fact that there are few USAID staff members familiar with institutional dimensions of irrigation development.

We recommend the following four actions to improve these problems. First of all, USAID should communicate clearly to the ID with which it is working that the scope of objectives included in the various projects cannot be achieved by the IDs acting alone, or with a small group of other government agencies. A larger network of resource organizations, some not traditionally involved with the activities of the IDs, must be engaged in the effort.

Then USAID should identify and arrange for some key Indian partners to jointly work on the institutional development components of the irrigation projects. These key partners should be experienced and respected individuals from one or more first-class Indian institutions able to work across State boundaries. They should be professionals who have been contributing to the new concepts of irrigation development and the management of public development programs utilizing rural participation. Moreover, they should have the capacity to develop and enlarge these corcepts in the context of USAID's irrigation projects. Identifying such Indian organizations and professionals will require some effort, but there are various possibilities such as several of the IIMs, the Administrative Staff College, some social science research institutes and various strong private voluntary agencies. These partners would work with the responsible State agencies and with whatever other institutions are available and appropriate at the State level such as universities, research institutes, private agencies, etc. Funds to support this partnership effort could be available under the action research component of the present IM&T project, but these would have geographical limitations and may be insufficient from the various State projects. In that case, AID will need to consider a new project as a funding mechanism for inaugurating this activity.

In working with these partners and their institutions, USAID will need to develop a style of interaction different from the usual "contractor" mode. High quality individuals and institutions will be interested in working with USAID on these problems only if there is opportunity to particiate in conceptualization of the issues and the full range of project planning and implementation.

Third, a representative, or representatives of these key partner institutions should be included in whatever is the important policy unit for the State concerned, i.e., the Minor Irrigation Committee in Madhya Pradesh or the Land and Water Development Cell in Himachal Pradesh. In

this way, institutional development issues such as Agency procedures or farmer participation can regularly be brought into these policy discussions for debate and action.

Finally, a plan needs to be developed for establishing a network of resource organizations in each of the five States with USAID projects. In some States this may be essentially accomplished already, as in Tamil Nadu. In others the process will need to begin with a careful monitoring of the resource organizations available. In addition, attention will need to be given to identification of the initial objectives of the network and the organizational setup and procedures by which the group will work. Again, the Indian partners identified above would be key in developing these plans.

Water User Organizations and Community Management

While all the USAID projects call for attention to water user organizations, little has been accomplished on this matter. This may be in part because USAID has accepted the idea that IDs will be responsible for user organizations. However, as noted in Chapter III, there have not been any special cells or other organizational units established to implement this part of the program except for a committee that has been formed in Madhya Pradesh. The only action has been to suggest that farmer organizing will be the function of the field staff of the ID, or perhaps the Agricultural Extension staff.

There are several reasons why the State Agency staff are unlikely to be successful in organizing water users. The skills required for farmer organizing are special and different than those required of the ID or AD field staff or agricultural extension. And, even if trained, there is a real problem with the work loads that the ID and agricultural field staff already have. Moreover, in the case of the ID field staff, serious attention to better irrigation system management should be the focus of any expanded, or revised, work program rather than organizing farmers. Finally, viable irrigation groups need a degree of autonomy from the ID. This is not likely to be achieved if the irrigation groups are the direct result of the IDs' organizing efforts.

This last point needs some elaboration. In recent years we have increasingly recognized the importance of reliable main system operation as a prerequisite for farmer organization below the public outlet. We know that it will be impossible to organize farmers at the chak level to maintain the canals, distribute water, collect irrigation fees and other things unless they are receiving a reliable water supply through their outlets. We have given less attention to the activities of such groups above the outlet, although in a few places there have been attempts to involve farmers in the inter-chak distribution of water along their minor or distributary canal.

What is less frequently discussed is the impact that farmer irrigation groups can have in providing feedback to system managers and monitoring the operation of the main system canals that serve their outlets. It is possible for irrigation groups to act as catalysts for better system performance by articulating their needs and pressing their demands for the system managers to be accountable in their operations. In this sense, irrigation farmer organizations are a key component in the strategy of improving main system performance -- along with the usual instruments of physical rehabilitation and staff training.

Four actions which we suggest for moving ahead with water user groups areas follows. First of all, USAID needs to demonstrate the importance that it places on farmer organizations. It should make it clear to the IDs involved that the strategy of organizing water user groups as identified in the various projects is not a strategy that can be directly implemented by IDs. IDs need to be closely involved, and there needs to be training to sensitize irrigation staff to the desirability and importance of farmer particiption in irrigation activities. However, the Departments must have the assistance as partners of non-governmental resource organizations to actively implement the organizing activities.

Second, at least one of the key Indian partners identified above should be experienced with matters of farmer organization, although they may not have specific experience with organizing farmers for irrigation development purposes. This partner should be an active participant in the State policy cell created to implement the AID project, as discussed above. This partner should help identify and work with one or more State-based PVOs who would actually implement farmer organizing activities in selected locations in the State.

Third, USAID should set the target of establishing one (or perhaps two) "world-class" pilot efforts with organizing water user groups on public canal irrigation projects in India. Other USAID missions in Asia with significant irrigation programs have achieved this, but as yet there is no good Indian pilot case to be referred to, discussed and debated. USAID's projects have in them sufficient financial resources to support such an effort. What remains to be done is to find a politically feasible way to divert these resources to the pilot efforts and establish the organizational resources for conceptualizing, planning and implementing these activities. This cannot be achieved by allowing the activity to remain the exclusive responsibility of the IDs. Thus, we see the need to engage an Indian partner (perhaps with support from U.S. groups experienced in this matter) to begin the process.

We suggest that Madhya Pradesh and one other State be selected for this initial effort. To begin this work will mean operating in existing minor tanks, since completed tanks under the USAID program are not presently available. If there is capacity to work with a second State, priority should be given to Himachal Pradesh because of the fundamental importance of water user groups for the community-management strategy of irrigation development in that project.

Finally, in developing a strategy for forming water user groups, consideration should be given to extracting lessons from and using the "catalyst" model that has been found to work in the Philippines, Sri Lanka and Indonesia. The core of this approach is that local workers, trained in specific skills of organizing farmers and employed by some group other than the irrigation agency, are fielded to assist farmers to identify their organizational needs for irrigation and to set up organizational arrangements to meet those needs. In considering the applicablity of the catalyst or any other approach, as a first step we recommend learning much more about the past experiences of the ID in organizing farmers in that particular State and about the types of irrigation groups that may already exist there. Besides the critical need to organize farmers, there is a package of technical services which is not now available at this level either, which includes design and construction of watercourses, their operation and maintenance, scheduling of water turns, mobilizing credit, optimizing field size, etc. These activities should be fully integrated with the organizational program.

Productivity, Equity and Economic Options

In Chapter III we suggest reasons for concern about the equity, productivity and economic prospects of Indian surface irrigation, particularly in the Deccan Plain where USAID projects are concentrated. The illustrative subprojects analyzed in the project papers are not necessarily the ones which will be proposed for actual USAID funding. Only a small percentage, perhaps 10 percent, of the subprojects that USAID will finally fund under the current irrigation portfolio have been identified, designed and appraised. This presents an opportunity for USAID to go beyond the narrow requirements of a 12 percent "design ERR" to seek a higher standard which we will call a 12 percent "realistic ERR." Pursuing this higher standard during the planning process should improve final project equity, productivity and profitability. The realistic ERR would be based on B/C analyses using reliable economic and engineering field data gathered on existing systems.

This section outlines a number of specific project design and administration changes. These are changes which our preliminary economic evaluation suggests might be undertaken to improve the productivity, equity and profitability of the yet-to-be designed subprojects. Although they obviously involve both engineering and institutional suggestions, they are presented from an economist's point of view. The engineering and institutional points of view of many of these same issues were addressed earlier. Without additional data it is difficult to estimate the relative potential of the 11 suggested changes which follow or to identify others. The importance of each suggested change and recommendations for additional ones will only become clearer when additional carefully-collected field data is available. Such data could be gathered as part of in-depth subproject appraisals.

The 11 suggestions which follow for improving the irrigation performance of canal irrigation projects are grouped in categories. The

suggestions should not be taken as final. They should be considered as flexible, with additions, changes or deletions made as new insights unfold. The importance of each is so site-dependent (soils, topography, market proximity, etc.) that generalizations are likely to be of limited use. The suggestions that follow form a sort of menu of possible changes which might be selected during the project design and appraisal at a particular site. Some may be relevant to a particular site, others may not.

Overextending Canals and Oversizing Reservoirs

Part of the high actual cost per irrigated hectare may be due to overextending canal systems and oversizing of reservoirs. Where canals are overextended the command areas which are reached by the canal systems are larger than can reasonably be irrigated at profitable levels of intensity.

1. Rather than overextending canals for questionable political reasons, it would be possible to reduce the cost by simply reducing the length of the canal systems without really reducing the area actually irrigated.

There is also a similar problem with oversizing reservoirs to increase the potential irrigated area during high runoff years. However, when there is an occasional full water supply the demand for the additional water may not materialize because such events are too infrequent and unreliable.

2. Reservoirs may in some cases be reduced in size (i.e., planned at higher rainfall probabilities) and thereby reduce the cost and increase the reliability of irrigation, without reducing the areas actually irrigated by much, even in high runoff years.

Underestimated Canal Seepage. If canal seepage is underestimated in the designs (as it appears to be in many), then the reach of the water in the reservoir will be correspondingly overestimated. Underestimating seepages leads to overextending canals.

3. The extra costs invested in extra canals which will seldom be used could be avoided by simply correctly accounting for seepage which would lead to not constructing the excess canals.

While shortening the canal will reduce the costs without reducing the actual area irrigated in most years, it will not capture the benefits lost through the excess canal seepage. This is an important benefit loss which might be recouped to a large extent by one or a combination of the following.

4. Seepage losses can be significantly reduced by selectively lining the canals in high seepage loss reaches. Losses can be almost eliminated by using fully lined canal systems or closed pipe sysems.

5. Return flow drainage water can be pumped back to the main channels or reused in downstream irrigation developments.

6. The number of wells inside and below the command can be increased to capture and reuse the seepage from the canal.

The conjunctive use option has the best potential for helping subprojects reach our proposed 12 percent "realistic ERR" planning standard.

Water Wastage in Headreaches

Faced with the difficulty of satisfying everyone's demands with an insufficient water supply, canal operators may in practice favor a subgroup of farmers. Most often the favored groups are concentrated in the headreaches. Some of this concentration of water, however unfair it appears, may result in significant economic and equity benefits because of the higher value and more labor-intensive crops which abundant water permits. When water is distributed equally from head to tail in an overextended canal system, productivity, economics and even socioeconomic equity may not be maximized. However, it is also true that if concentrating water in headreaches results in simple wastage of water through lack of night irrigation and/or overwatering of crops, then the productivity, economic and equity benefits will be even more adversely affected.

7. Improvements, including water controls and measuring structures, and procedures which can significantly reduce water waste in headreaches and force this water further down the system should be made. This would increase the area actually irrigated, and while not reducing the costs, would increase the benefits.

In pursuing the economic potentials of more spatially equitable distribution of water, project designers and appraisers should gather the necessary field data to assure that real wastage (overwatering and night waste) is not occurring. They should not force water down the system which may be lost to seepage in transit; and/or have higher productivity, economic and equity benefits at the head than at the tail. Moving water further down the system is not always better, even from a socioeconomic equity point of view. Field data, specific in each project situation, not generalized design assumptions is needed to properly assess these important issues for each subproject.

Crop Restrictions

It appears that in many situations certain water procurement regulations are reducing the reliability and profitability of the water delivered. In some cases this results in an actual lack of farmer demand for water,which results in wastage and underutilization below the outlet.

8. The wastage and lack of demand could be remedied and project benefits increased by eliminating restrictions on crop patterns and procedures and by changing the water delivery to depend more on farmer organizations and rotational water supply systems. In those cases where crop restrictions have limited the growing of high value labor-intensive crops, the increased socioeconomic benefits could be very substantial.

Changing Seasonal Patterns of Water Delivery

Many canal-reservoir irrigation systems are designed to provide water during kharif or in other seasons when farmers cannot make very profitable use of irrigation. In contrast, farmers are often able to make very profitable use of hot, dry season summer irrigation on high value perennial and other cash crops. Designing and administering systems to provide low profitability kharif irrigation instead of summer water may lead to unnecessarily reduced benefits.

9. In many cases canal-reservoir irrigation projects may be helped in meeting economic and equity criteria by designing and administering them to reduce kharif deliveries and/or start or increase summer deliveries of water.

It is certainly true that holding water longer in the reservoir means additional evaporation loss and a reduction in the total water available for irrigation. This must be balanced against the profitability of irrigation in different seasons. The only way to know which will be best is from actual field data and experiences, not from generally accepted assumptions. From the data we have reviewed it would appear that many of USAID's Indian canal-reservoir irrigation projects could come closer to meeting economic and equity criteria if the design and administration assumptions were changed with respect to the seasonal distribution of water. However, this may not help ERRs of subprojects in which the unprofitability of kharif irrigation has already been noted and discarded in the B/C analysis, as in the Maharashtra Medium Irrigation Project.

Using Water More Than Once Before It Leaves the System

Another possibility for helping future subprojects meet economic and socioeconomic equity criteria would be to design and administer projects

to use the stored water more than once before it leaves the command area. We have already discussed capturing canal leakage through well development pump-back systems. In addition to capturing canal leakage, well development in the commands would also capture much of the deep percolation water resulting from surface irrigation applications. The Central Groundwater Board told the Team they estimate that an average of about 30 percent of the irrigation water applied ends up as available groundwater inside the commands.

10. In many cases medium and minor irrigation project benefits could be as much as doubled by designing and administering them to utilize irrigation return flows. This can be accomplished through better organized well development and other pump-back or return flow schemes in the command or slightly below it.

Spreading Water Productively and Equitably

We have noted that what must be reduced so that USAID's subprojects meet economic and social criteria is not the total system cost, but the cost per unit of benefit. If the volume of water stored in a reservoir could be spread reliably and productively across a larger area in such a way as to permit or even favor high value crops, such an alternative could help a project meet economic criteria. That is if the cost of "stretching" the water was not too high.

It might be possible in some situations to double the reach of of water by using sprinkle and to triple it by using trickle irrigation. The incremental cost of such application methods over traditional methods might be on the order to $500 to $1,000/ha. This may be a very attractive way of reducing the cost per irrigated hectare of expensive canal-reservoir irrigation systems. For example, assume the headworks and canals of a system designed to irrigate 1,000 ha cost $4,000/ha as designed, and adding sprinkle and/or trickle irrigation to the design would increase the area to 2,000 ha at an incremental cost increase of $1,000/ha. The improved system would have a total cost per hectare irrigated of only $3,000. Thus, it can be seen that providing the more efficient water "spreading" technologies would probably reduce average capital costs per hectare actually irrigated by a significant margin in many projects. However, these improved technologies require reliable and timely water deliveries which are difficult to achieve with ordinary canal delivery systems. Thus, lift pumps feeding various sized pipe distribution systems supplied from open channels, wells, tanks or drains should be considered along with them.

11. In many cases total irrigation costs may be reduced and benefits increased by incorporating improved application techniques such as precision surface leveling, sprinkle or trickle irrigation in the project design.

Concluding Comments

The above 11 potential redesign and management or administration changes are simply a menu from which to select possibilities for analysis and redesign at the subproject qualifying appraisal stage. If misused in the absence of actual field survey data as simply a new set of assumptions which can help project designers give the appearance of a new "higher" standard, they could easily do more damage than help. These ideas should be treated as high potential "hypotheses" to be used in serious field data based project appraisal. They should not be misused as a new way to avoid serious project appraisal with a new set of manufactured engineering and economic assumptions.

Gathering data at unconstructed sites will possibly be more helpful to engineers than economists because one cannot measure or survey the economic results of systems as yet unbuilt. Therefore, the economic part of appraisal efforts must involve gathering field data from existing systems and using this actual field data to build and test the feasibility of the economic impacts of design changes. This takes careful professional work and can, if misused by project "justifiers" as opposed to serious project "improvers," bring one back to a "numbers charade" based on biased field data. If one wishes only to justify projects rather than to improve them, field data can be as improperly used and interpreted for that purpose as can engineering and economic assumptions and projections.

We believe there is an excellent opportunity to improve USAID's irrigation portfolio with the addition of a few hundred thousand dollars invested in significantly improved subproject appraisal and subsequent monitoring using our recommended "realistic ERR" field data based procedure. We realize the additional planning burdens that the higher this would entail, and the consequent delays in subproject implementation. Therefore, we recommend applying the proposed new planning process on only a sample subset of the many subprojects which USAID will have to appraise and approve. Certainly no one could object (on AID regulation grounds) to allowing the bulk of the projects to be held only to the "design ERR" standards. It is unreasonable to force all AID projects to a new standard, especially when to do so would substantially delay implementation and further exacerbate cost increases, project delay and money flow issues. One should not forget that delays in completion after investments have begun cause a worsening in the B/C results because of the time value of money.

A sample of perhaps 10 percent of the canal-reservoir subprojects would appear to be a feasible and useful number to be lifted to this new, higher B/C design standard. An important issue for USAID will be how to involve the IDs' local institutional partners and USAID personnel in this more intensive appraisal process. Some of these suggestions are already included in the AID criteria at least in part for qualifying projects. There should be no implication that these are to be voided or relaxed on the other subprojects. As mentioned earlier, USAID needs to increase its efforts to insure that all subprojects meet its present standards.

CHAPTER VI

RECOMMENDATIONS FOR FUTURE PROGRAM

This chapter discusses options for future USAID activities in the irrigation sector. In the first section suggestions are made regarding program design and program management and implementation. In the second section several options for future program actions in both surface water and groundwater development are identified. The third section makes suggestions regarding the ongoing program.

Program and Project Development

There is a serious need for longer lead times and more background studies and preparation for future projects, as discussed earlier. Both GOI and AID/W policies apparently will preclude any significant increase in direct hire staff. Moreover, there are significant disadvantages in always having to work through short-term expatriate planning teams.

An alternative is to develop long-term relationships with key Indian institutions that have the capacity to conduct background research, explore possible program lines and otherwise participate with USAID in the conceptualization and initial planning of new program areas and in the further implementation of current projects, particularly IM&T. Such national institutions could play a role in the implementation stage of projects, often working with and through State-level institutions for various project activities. In addition, this arrangement with key Indian institutions would allow a logical point of contact between any U.S. expertise involved in the project planning and development stage in addition to the linkage that such consultants would have with AID staff.

Geographic Concentration

The present portfolio of irrigation projects already involves USAID with six different State governments as well as the Center. Geographic concentration would not only have a positive impact on practical matters of travel and logistics, but allow Mission staff and staff from the key Indian institutions working with USAID to become familiar with and known to the important irrigation policy makers and implementors in those States. Therefore, in planning future irrigation activities, such as those discussed below, USAID should first consider implementing those activities in one or more of these six States. However, given the extreme poverty and irrigation potential in Eastern India, as discussed in Chapter IV, USAID should look cautiously at possibilities in that region, particularly as they relate to groundwater development.

Specific Program/Project Models

The Team proposes looking at a few new program/project areas or models. These are: (1) direct assistance with canal irrigation system operation management and maintenance, which would nicely fit as a project in the current USAID irrigation program; (2) direct assistance to local sector irrigation which involves the rather large set of small surface irrigation projects accounting for approximately 5 percent of all surface irrigation in India, but generally falling outside the jurisdiction of the State IDs; (3) development and testing of a model of improved system management through rehabilitation and disaggregation of a large major canal reservoir irrigation system, plus ongoing management assistance; and (4) commercial groundwater development with a focus not only on well development but also on technical assistance with pumpsets, improved application systems and marketing.

Irrigation System Management

The current AID portfolio of irrigation activities does not directly deal with OM&M. It does not involve continuing activities on the systems financed once they have been commissioned.

The major impact on OM&M by the State projects will be indirect through improved systems which provide better control of where the water goes through installing additional gates, checks, measuring devices and bypass structures for cross-drainage flooding. States, by policy, did not install lining on medium and minor projecs. Lining is being required on many channels under USAID projects. Properly designed and constructed, lined channels are much easier to operate and maintain than earth ones. Farmers cannot cut the banks as easily, weed growth and erosion is nil and water can be moved to new delivery points with less delay because the water runs faster.

By requiring development of water scheduling on a rotational basis, the water demands will be more orderly and less ad hoc. A significant part of the Water Management and Training Project is focused toward OM&M. This should increase professional competence and bring focus to bear on improved institutional arrangements.

A natural and useful continuation of the existing program dealing with canal irrigation would be a project involved in managing systems after commissioning. Such a project should be directed at demonstrating what improved management can accomplish, along with minor system modifications. This would be a natural outgrowth of the experiences gained from the IM&T Project "Irrigation Management Action Studies" (heretofore called "Action Research").

The Team recommends that USAID should concentrate on a few medium or clusters of minor projects, ideally ones that are in USAID's current construction portfolio. The OM&M project would include:

- Complete project analysis involving baseline and water budget studies;

- Providing resources for and carrying out limited physical changes or additions based on optimization analysis. These should include modern technologies such as computers and radio communications where appropriate;

- Developing operational/management programs for each project;

- Providing resources for the OM&M of the project for at least a three-year period;

- Providing resources for support systems such as field improvements, extension, farmer organizational activities, etc., and

- Monitoring the results of both system performance and farmer response on a continuing basis throughout the project period.

This would be a very useful pilot model. In the meantime, USAID might give attention to the generic problem of inadequate budgets and institutional arrangements and capacity for improved OM&M. Unless OM&M is greatly improved, the prospects for achieving improved utilization on AID projects are dim.

Local Sector Irrigation

The term local sector irrigation is used to refer to that subset of irrigation, usually small surface systems, that is outside the responsibility and control of the IDs and not owned by individual operators, as with most well irrigation. Local sector irrigation systems are under the control of units of local government such as village or district water user groups. It often is the case that these systems receive some assistance from government agencies such as the Agriculture or Rural Development Departments.

The Mission is working with this sector in a modest way in the Himachal Pradesh Project since under that project some support is being directed through both the Agriculture and Rural Development Departments. The assessment of the local sector irrigation activities of these Departments in Himachal Pradesh suggested the following points. First, both Agencies follow an implementation strategy that mobilizes local resources to be combined with the Agency's resources. Furthermore, Agency assistance is provided in such a way that local groups are responsible for continuing to operate and maintain the systems after project assistance has been received. And finally, the Agencies, particularly Rural Development, frequently are short in the technical backstopping required to make the investments in the system effective. Preliminary assessments suggest that the local irrigation sector is significant in at least three of the other States in which USAID is working, Maharashtra, Madhya Pradesh and Tamil Nadu.

Assistance to the local irrigation sector has potential interest for the following reasons:

- The local sector is much less State-dependent, particularly in the post-project stage, thus allowing the State to invest in irrigation improvements without increasing the recurring costs to government through continued maintenance and management responsibilities;

- The local sector of irrigation is locally managed and has a history of mobilizing local resources for irrigation development, sometimes to complement State-provided resources;

- The local sector is free of some of the controls on water use and crop choice that are involved in the irrigation sytems managed by the IDs, thus providing scope for market responsiveness and rapid technical change;

- The local sector would permit focus on the rehabilitation of existing facilities rather than creating new ones, thus avoiding some of the difficulties of developing new facilities at increasingly marginal sites; and

- The local sector could allow USAID to influence irrigation development activities in India through agencies that may be less monolithic and rigid than many of the State irrigation agencies.

If further consideration of the local sector as an opportunity for future USAID assistance is of interest, there is need to begin a careful review of the historical development and present situation of local sector irrigation, either an all-India review or a review of selected States. This review would also identify the present constraints in this sector, the possibilities for future development, including economic viability, and the key institutional actors with whom USAID would have to deal in working on this topic.

Improved System Management Through Disaggregation

The present architecture of some surface irrigation systems in India makes than unmanageable by even a well trained and motivated ID staff, and impervious to local management input. Thus, there may be value in pilot efforts that aim at "reconstructing" these large commands into smaller, intermediate units of management that would both allow for better ID management and increase the opportunities for community mangement input.

There are examples of this disaggregated design model in both India and elsewhere. The systems tanks of Tamil Nadu, for example, represent this conceptual approach. Likewise, selected systems in southern Maharashtra, the so-called Sangli model, incorporate some of these features. Observers of Chinese irrigation have referred to the "melons-on-the-vine" systems that are composed of a series of small

storage ponds linked by a large delivery canal. Similar systems exist in the Western U.S. Additionally, disaggregated systems could be created through the placement of groundwater facilities in the surface command, thus "separating" the well command from the canal command.

What is proposed is that this approach may complement other approaches being taken to improve main system management, in particular large commands (medium or major) that are technically difficult to operate and manage. There would be need for a rather long investigation period that should begin with studying any prior experiences of this nature in India. This initial investigation period might support an interdisciplinary research group to do some brainstorming and modeling of possible approaches. It could also be a period for preliminary investigation of possible locations for field testing ideas. Possibly, this set of preliminary tasks might be conducted by the International Institute for Irrigation Management (IIMI) in collaboration with Indian colleagues.

The Commercial/Groundwater Model

Under this model a project would be designed to provide financial and technical assistance to private farmers organized in commodity and other cooperatives for the development of wells, energized pumpsets, sprinkle-trickle application systems and market/processing. Providing assistance to irrigation and commercialization is the central idea of this model. The model would involve financial and technical assistance in the two major components, irrigation and marketing/processing.

Irrigation Component

Financial. AID financial assistance for the irrigation component of the project could be channeled through the NABARD system to individual farmers and/or through the cooperative banking structure to the commodity cooperatives. A preliminary review of the untapped groundwater potential on small farms indicates a possible demand for finance in Maharashtra alone of some 1.4 billion U.S.$.[1]

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[1] The GDSA in Maharashtra has conducted detailed groundwater potential surveys in most of the State and estimate that "34,996 million cubic meters of groundwater is annually replenishable against a total annual draft of 7,471 million cubic meters through the existing 939,000 irrigation wells. The balance of 27,778 million cubic meters is left over for further development through additional 1,800,000 new dug wells." In the Deccan, tubewells are rarely possible, the major potential is in single farm dug wells irrigating from .5 to 3 ha area. Small farms in Maharashtra have 297,000 of these wells already and have existing potential for some 700,000 additional wells. At an average investment cost of approximately U.S.$ 2,000 each, this would indicate an unmet demand on small farms in Maharashtra of some 1.5 billion U.S.$. The expected ERR using current USAID methodology would be 70 to 90 percent (see Maharashtra IT&M Project Paper and USU study by Mulik and Sawant, Annex II), though "actual" expected ERRs would be much lower (perhaps in the 30 to 40 percent range) when misuse and diversion of credit funds and default are added in at realistic levels.

Technology. Technical assistance in the irrigation component could be channeled through the Groundwater Survey and Development Agency[2] and the technical-engineering staffs already functioning in the various banks.

Marketing/Processing Component

Financial. Financial assistance in the marketing/processing component of the project could be channeled through the banking structure to the commodity marketing and processing cooperatives. Rural electrification could be an additional financial component.

Technology. The technology component in marketing/processing would be a vital part of the model and would be channeled to the commodity marketing/processing cooperatives (such as the Grape Growers and Marketing Cooperatives) through the Agricultural Universities. MPAU has a Food Processing Department with important potentials for this role.

This model would probably best be developed and tested in Maharashtra, not only because this is the State where AID is most deeply involved and experienced in the Deccan, but also because of the market potential of Bombay and its access to international markets for commercial agricultural products.

Analysis leading to this model may be found in Chapter III in the section on Conjunctive Use and Groundwater Development and in the conjunctive use section of Chapter V, in Annex II and in Appendis C. The 1963 Maharashtra Irrigation Commission Report referred to this development model as the "promising path" for irrigation in Maharashtra. A recent case study at Mahatma Phule Agricultural University traced this model as it has evolved in the Sangli District of Maharashtra. The quote which follows deals with lift irrigation and sugarcane cooperatives from 1958 to 1975.

> Till 1958, the district (Sangli) was considered to be agriculturally backward, as the agriculture in the district was mainly dependent on rainfall and there was absence of commercial outlook among the farming communities. Agriculture was, moreover, of subsistence nature. But since the establishment of cooperative sugar factories at Sangli (1958-59) and Walwa (1969-70) the district has undergone a tremendous change. There was a shift in the cropping patterns, mostly from food grain crops to commercial crops like sugarcane. As sugarcane, being an irrigated crop fetching considerable net returns to growers, it motivated many of the

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[2] The Groundwater Survey and Development Agency (GSDA) in Maharashtra is an "Independent Directorate of the State Government" charged with the analysis and technical guidance of well development in the State. They have a technical cadre of 1,493 employees and 481 administrative support personnel.

cultivators to exploit and use the irrigation resources (mainly through farmer organized lift cooperatives). This needed necessary financial help and supply of inputs as well. The cooperative institutions in the district came forward to meet this need, and as a result of this cultivators were able to get required agricultural inputs including credit in sufficient quantities. This accelerated the process of agricultural development in the district. The efforts towards exploitation of natural resources yielded desirable results. This not only increased capital formation in agriculture, but also increased the productivity of all other resources including land, thereby increasing the incomes of the masses.

This quantitative study, which should be particularly interesting to AID, explored the impact of public subsidized credit schemes such as those of the ARDC and its affiliated cooperatives and land development banks on deposit mobilization in rural areas. Its positive findings were that the initial infusion of subsidized credit created substantial increases in productivity and subsequent deposit mobilization. This may seem a small point, unless it is realized that it was exactly the opposite hypothesis (that subsidized credit would injure deposit mobilization) which was used to defeat AID's earlier groundwater finance project in AID/W. This and other studies might be used to overcome such a position with reference to the Deccan if, in fact, it persists in AID/W.

A second round (beginning about 1975) of activity is now recycling in the same district based on well/lift irrigation and table grape growers cooperatives. The equity impacts on employment and income of landless and poor farmers appears to be substantial. This model is derived from and supports the kind of market driven "commercial transition" in agriculture which Chapter I sees as the next plateau up for Indian agriculture. This process may be seen in the MPAU case study:[3]

A further persuasive analytical base for combining commercial/agroindustrial efforts with irrigation projects may be found in a recent CWC study involving the three States of Karnataka, Andhra Pradesh and Tamil Nadu. This study, summarized by Nadkarni in a recent article ("Irrigation and Rural Development," Economic and Political Weekly, June 1984) outlines the extensive CWC field surveys in 15 villages to measure the impact of irrigation on rural poverty. The conclusion of the survey is that irrigation alone had rather disappointing impacts, but when it was associated with rural/agroindustry the absolute[4] impacts were substantial.

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[3]Mahatma Phule Agricultural University, Deposit Mobilisation on Farms in Sangli District of Maharashtra, Rahuri, 1982.

[4]As in all studies we have reviewed, while absolute impacts on poverty may be positive, the gap between rich and poor also appears to widen. See discussion earlier in the section on Rural Equity and Employment in Chapter III and background papers.

A preliminary review of cooperative and land development banks in Maharashtra indicates that while default and loan administration continue to be important institutional constraints, there is an unmet credit need in small farmer groundwater development and considerable interest in improved technology.[5]

Ongoing Program

Issues relating to continuation of the ongoing program were discussed in Chapter IV. For the two medium irrigation projects, none of the subprojects will likely be completed, including chak development, within the financing provided and time limits of the Project Assistance Completion Date. Considering that USAID will have gained a great deal of locale-specific expertise with these subprojects, they could be interesting candidates for incorporating the Irrigation System Management Model referred to above. This would argue for continuing support for their completion so that they could be effectively phased into the OM&M stage. For the in-service and University training and Hill Area Development programs, the Team recommends that decisions for these be left open pending appropriate evaluations.

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[5] This review was undertaken in the Nasik District in 1983 by S. Daines as a part of the Institutional Analysis of Irrigation. District cooperative and land development banks were visited and the issues of default, loan administration, credit demand and irrigation technology were explored. The technology interest of the land development banks was significantly higher than the cooperative banking structure and their technical capabilities appeared correspondingly better. There was a significant line item in their portfolio for sprinkler irrigation on wells which they said had been opened based on small farmer demand.

ANNEXES TO MAIN REPORT

I. SUGGESTED POINTS AND ARGUMENTS FOR THE IRRIGATION TEAM REPORT

by Carl H. Gotsch

II. UTILIZATION OF GROUNDWATER IN HARD ROCK AREAS

by Dean F. Peterson, Budhajirao R. Mulik, Manohar M. Sawant and Jack Keller

ANNEX I

SUGGESTED POINTS AND ARGUMENTS FOR THE IRRIGATION TEAM REPORT

by

Carl H. Gotsch

SUGGESTED POINTS AND ARGUMENTS FOR THE IRRIGATION TEAM REPORT

by

Carl H. Gotsch

The basic strategy developed in the USAID irrigation project papers is to use the evidence from a series of activities in selected States to encourage Indian irrigation planners to make certain performance enhancing design and management changes in the vast GOI water resource development program. To make such a technology transfer objective viable, the Mission has committed a sizable amount of its own resources to the construction and organization of both medium and minor irrigation systems. These investments are relatively small when compared to the funds targeted for the all-Indian programs over the next several plan periods. However, by concentrating activities in a limited number of areas, the magnitude of the AID involvement is sufficient to add financial leverage to the technical assistance program that is ultimately the major U.S. contribution.

There is a strong case for such a learning and demonstration strategy. Using conventional benefit costs analysis based on widely accepted engineering standards, the proposed projects have met the ex ante estimated 12 percent ERR demanded by both the U.S. and Indian governments as the cutoff point for acceptable projects. The documents also make clear, however, that if historical costs and utilization rates were used in the analysis, the same calculations would yield ERRs that were substantially less than those projected. The reports have identified a variety of problems that contribute to these results: improper reservoir sizing, graft in construction, lack of appropriate control structures, inability to manage the systems equitably, etc. The effect has been to create a substantial gap between net returns computed on the basis of utilization rates assumed to be attainable if the systems were designed and managed properly and those actually observed. The argument that this gap can be closed with improved construction and management practices constitutes the core of the Mission's irrigation assistance strategy.

The Team's Findings

Point One: Strategy

The Team finds that the basic strategy for assistance in the irrigation field is as valid as when it was first written several years ago. Indeed, new evidence has come to light that makes the need to improve the Indian irrigation effort even more compelling than when the idea of AID involvement was first proposed. Both costs and benefits are involved:

1. New empirical evidence made available to the Team suggests that current utilization rates may be even lower than those assumed in the

project documents. For example, in the minor irrigation project used to calculate the benefit-cost ratios mentioned above, it was noted that a utilization rate of roughly 65 percent would be required in order to achieve a 12 percent ERR. The average current rate from a representative minor was said to be 45 percent, implying that a difference of approximately 20 percent in benefits would need to be made up by the proposed management improvement measures. Subsequent survey data suggest that the current average utilization rates may be closer to 30 percent, leaving a difference of 35 percent to be made up by measures that have been proposed to improve system performance.

2. It has become evident that there have been considerable cost overruns in recent irrigation projects. As of last reckoning, these estimates appear to be 40 to 60 percent higher than those included in the project paper, although it is difficult to tell how much of this is a result of revised estimates of actual costs and how much is a result of inflation. The cost overrun problem has appeared not only on AID projects, but on the much more massive World Bank projects as well.

Moreover, in addition to the higher costs, present performance suggests that the implementation schedules are also optimistic. That is, it will take longer, on the average, to complete the construction than the schedule in the project paper implies. Both of these construction factors will act to widen the difference between the targets set up in the project analysis papers and what current performance suggests is likely to happen in the absence of significant changes. Indeed, if past performance were the basis of the calculated ERR, the difference to be made up by the improved measures is likely to be on the order of a full 12 percent in the ERR.

The project level disaggregation that needs to be done to ascertain if the proposed improvements are feasible is the subject of much of the Team's report. Whether the 12 percent figure is actually reached or not is, at this stage, of relatively minor significance. The Indian Government's own objectives are consistent with those used by AID and they are presently committed to a major irrigation program that is unlikely to stop in midstream. Consequently, the additional empirical material that raises questions about the "planning gap" only underscores the urgency with which the Mission should press home the implementation of its strategy. Policy discussions may need to be conducted at the highest levels of Indian planning to create an awareness that the problems with the GOI's surface water irrigation strategy are much more widespread than was thought to be the case.

Point Two: Strategy Implementation

While the Team finds that the Mission's strategy is sound and that the necessary resources are in place, it also believes that it may be desirable to do some rethinking about the follow-up or implementation process. Two major issues were discussed, both within the Team and with the Mission:

1. Currently the bulk of the Mission's funds are being spent above the "outlet," i.e., the point at which the Irrigation Department ends its responsibility for delivering water. However, the major portion of its technical assistance program concentrates on the activities below the outlet. These represent, to a considerable extent, the institutional concerns, e.g., farmer organizations, local participation in system design, etc., that have been important in AID's international program of assistance to water resource development.

The Team found evidence that awareness of below-the-outlet problems have become more widespread within the Irrigation Establishment. However, the result to date has been to develop staffing patterns within the Ministry of Irrigation that attempt to deal directly with the inefficiencies of farm level utilization. Even where well-intentioned, the effect has been to move department staff into roles for which they are poorly equipped and for which they are unlikely to be rewarded by standard Agency procedures.

Below outlet activities will continue to play a significant role in the Mission's India program. The Team's discussion suggested that, although there are inherent problems with any approach because of the quasi-adversarial relationship that pits the Irrigation Department's desire to control water against the cultivator's desire to do the same, two routes are open for improving below outlet efficiency. One option is to work through the Irrigation Department by persuading them that it would be in the Department's interest to entrust the lowest level management functions to some type of farmer organization. So long as ultimate control of water supplies resides with the Department, it is conceivable that the latter would be prepared to cooperate with organizations that have a special expertise in developing management capabilities and community organization. The incentive in this case would be the Department's recognition that poor performance on its schemes is not in its own long-term self-interest.

Another alternative would be to work through other recognized agricultural bodies such as the Department of Agriculture. Again, there would undoubtedly be the need for an Indian collaborator who would be funded to perform a task for which the Agriculture Department was unsuited. In both the Irrigation Department and the Agriculture Department, care would have to be taken so that the organization actually working with farmers understood the limits of their mandate. However, joint meetings between the Irrigation Department and organizations that represented management specialists, researchers and resource groups accustomed to viewing problems from a cultivator's perspective could be useful to all concerned.

It is obvious that the activities described above will need a good deal of field testing. However, the view that all relationships between government agencies, extra-governmental bodies and cultivators are adversarial to the point where confrontation is the only mode of interaction, is destructively simplistic. In the Team's view, modest

efforts to try out different models in different States at the field level should be an important and continuing part of AID's activity.

2. While it is the view of the Team that the below-the-outlet implementation activities should be continued, it is also the Team's recommendation that two other areas of implementation should be expanded. Both speak to the fact that the major opportunities for narrowing the gap between current and targeted performance are likely to be in improving the effectiveness of the system above the "outlet." The first item has to do with changes in the basic design of the systems that are being constructed. There is ample evidence that the current design and appraisal methodology produces projects that are inherently incapable of achieving the efficiencies projected in the project papers. Considerable thought has already been to this type of work, but only modest efforts have been made to disaggregate the appraisal process to the point where individual parameters (crop water use, cropping patterns, canal leakages, reservoir sizing, etc.) can readily be confronted with empirical parameter estimates. Incorporating a better analysis of the existing systems into an analytical framework that subsequently produces more understandable projects ought to be an important goal of the implementation process.

No matter how carefully the design is done, efficient system performance still requires good management. In fact, over time the interaction of management and design ought to become a continuous process, one which has already been incorporated into the justification for below-the-outlet activities. To date, however, there has been little attention in the general AID water resource development program with a direct involvement in the function of the main system. The Team believes that this is a serious oversight, one that needs to be dealt with if the Indian strategy is to be implemented effectively.

Pressing for a program of improved management of the main system may well entail some additional construction commitments. These will have to be weighed against programs discussed elsewhere that have a higher rate of return (most notably, groundwater development). But the argument for incurring additional costs to support management activities on selected main systems would be consistent with the general Mission strategy of trying to affect the entire system by demonstrating the desirability of changes on a limited number of projects.

Obvious sites for implementing such above outlet management systems would be the medium projects in which AID is already involved. (In the Team's view, except under unusual circumstances, e.g., direct requests from the Irrigation Department, efforts to assist with the management of systems that are already in place, are likely to be unproductive.) How far the Mission should go along this line, i.e., in committing additional resources to the surface water irrigation portfolio, should be the subject of considerable discussion and negotiation. In the Team's view, the resources that have currently been committed are sufficient to provide the basic credibility for the Mission's strategy. However,

adding a more explicit main system management component may well suggest some additional expenditures to permit the fine tuning of the system. These could have a high payoff provided that the additional resources were very specifically targeted on the management issue.

Point Three: Making an Implementation Agenda Operational

The observations made under Point Two suggested that some refocusing of the Mission's attention could usefully take place in the implementation stage. These comments raise two further questions:(1) how can the Mission select among the wide variety of issues in each of the major categories (assessment and design, system management and below outlet organization) those that merit inclusion in the policy dialogue with the GOI and State Governments; and (2) how should it try to secure or develop the human resources to pursue the items that are selected?

The agenda to be used as a basis for policy dialogue with the GOI obviously cannot be a laundry list. It will be ineffective, in discussions with the Irrigation Department, simply to recite the list of activities that, if pursued, would improve the performance of the project. If the Mission is to play a more aggressive role in pressing home its strategy, certain areas will have to be singled out for special attention.

To form the basis for the identification of those elements that should be followed most closely in the implementation process, the Team recommends that a more disaggregated "model" of the proposed medium and minor irrigation schemes be developed. Subsequent parts of the report spell out the pieces of such a framework in greater detail. However, to take but one example, much of the discussion about the inefficiency of the present system has centered around the empirically observed utilization rate. It is indeed the case that when the targeted irrigated acreage has not been attained, the benefits of the project are considerably less than projected. A variety of factors, however, may be responsible. First, the area included in the scheme may have been in excess of the amount of water that is actually available at the reservoir. Alternatively, the losses between the reservoir and the field may have been much greater than was assumed in the design. Still other possibilities include incorrect assumptions about the cropping pattern and about crop water requirements. Without a substantial amount of disaggregation, it will be difficult for the Mission to develop a platform from which to engage in the appropriate policy dialogue with the Irrigation Department.

The same type of problem arises on the cost side. So long as there is no disaggregated model of reservoir sizing, the economics of canal length and canal lining, etc. along with the associated cost estimation, it will be difficult for the Mission to target its policy discussion with the Irrigation Department on those portions of the "planning gap" that appear to be the major source of the difficulty.

The development of such an analytical framework will probably require the use of local consulting firms working in conjunction with the Mission and with the Irrigation Department. However, the mere fact that the various technical aspects of improving the functioning of the system are the subject of regular discussion, and that evidence is being gathered and evaluated, would be an important visible step in the implementation process.

A problem that confronts all efforts to move from the strategy and resource commitment stage to the implementation and monitoring phase is the availability of Mission personnel that can be assigned to the task. As noted previously, the current concentration is on the below-the-outlet problems, while a major part of the system inefficiencies appear to be in the design and management of the system above the outlet. In trying to redress the balance, the Team is aware of the limitations on direct hire personnel; however, it is equally persuaded that a more intensive and visible involvement with the implementation with the irrigation portfolio is necessary if the Mission's strategy is to succeed.

The obvious, and perhaps only, alternative to hiring more expatriates is to involve one or more Indian consulting firms in evaluating and monitoring project performance. The Team is aware that this suggestion is fraught with difficulties, many of which are similar to those that will be encountered in efforts to improve the efficiency of water management below-the-outlet. On the one hand, it is important that the consultants have the confidence of the Irrigation Department. On the other, it is equally important that the individuals, many of whom have been former employees of the Department, be able to preserve their professional integrity in rendering judgments about the Department's efforts to comply with the guidelines that have been established. Importing a large number of expatriate personnel is infeasible and probably undesirable. However, if the Mission can develop a clearer picture of its own agenda, the use of Indian intermediaries becomes a viable option in implementing the program's strategy.

Time will tell whether the changes that have been programmed into the resource commitments have the intended effect. None of the projects that have been initiated under the AID program have matured, and there is as yet no experience with their operation. However, based on the available evidence, it is obvious that there is no room for complacency and an aggressive and viable effort by the Mission to implement the program will be required.

Point Four: Investigating Alternative Water Resource Investments

The payoff to the current strategy comes from its ability to influence the way in which a much larger development program is implemented. Projects may not achieve the intended 12 percent, but even small improvements in the efficiency in what appears to be a large GOI

commitment would be a highly desirable investment. In thinking about future directions, however, there are attractive alternatives to further surface water investments, particularly in the area of groundwater development, that deserve investigation. Admittedly, past efforts in this area have shown that, from AID's point of view, there may be problems of program design. But the ERRs from tubewells and dug wells are roughly 30 to 50 percent, or an order of magnitude beyond those that can be expected from surface irrigation projects. That alone is a sufficient ground for exploring these types of programs in greater detail.

Some of the problems of program design can be addressed directly; others merit more investigation and consultation with Indian authorities:

1. Currently, tubewells and dug wells in the areas in which AID is working employ relatively traditional methods of construction. Moreover, because of the nature of the underlying aquifer, water yields are low. In selected sites, it appears that the scarce but seasonal water available from wells can be extended substantially by using modern distribution methods. Low pressure sprinkler and trickle irrigation as well as traditional drip systems appear to have considerable promise. Other water saving devices such as plastic shields to decrease soil evaporation, a technique being exploited extensively in the North China Plain, may also be appropriate. Naturally, such methods of improving water efficiency presuppose an agriculture devoted to high value crops such as grapes and other horticultural enterprises. However, there are agroclimatic niches in a number of the States where farmers have already demonstrated that providing high value crops for nearby domestic markets can be a profitable undertaking.

2. Relating a groundwater-advanced irrigation program to the theme of technology transfer is appealing. However, devising an institutional mechanism by which this can be accomplished will require imaginative program development. The problem lies in the fact that there is no good interface between the private sector, upon whose incentive the program's implementation depends, and government agencies who might encourage technology diffusion. In the past, AID has attempted to facilitate diffusion by making a line of credit available to what was then called the Agricultural Refinance Development Corporation. ARDC subsequently made the funds available to participating Cooperative and Land Development Banks. The objection to this type of assistance was that it was purely a resource transfer; the magnitude and diversity of the overall agricultural credit program to which AID was contributing was such that the link to groundwater development could not be easily identified.

The State of Maharashtra, recognizing similar difficulties, has recently initiated a program targeted specifically at improving the incentives to develop groundwater and to utilize micro-oriented distribution systems. For example, it has exempted the plastic granules that are required in the manufacture of drip and sprinkler components

from the normal excise tax of over 100 percent. At the same time, it has announced a subsidy of 25 to 50 percent on certain types of pumps and other equipment that would facilitate groundwater development.

Exploration of a more targeted approach to increasing private sector incentives in the groundwater development area holds considerable promise. By focusing the subsidy directly on the technology, it facilitates the diffusion process and encourages the multiplier effects on which the justification for subsidy programs rest. At the same time, it avoids the problem of disturbing rural capital markets with blanket interest subsidies which may or may not result in the installation of the technology on which the improved efficiency of groundwater use depends.

The general argument for facilitating private sector involvement in areas that traditional farmers find risky could also be extended to the manufacturers of advanced irrigation equipment. In Tamil Nadu, several small manufacturers have already begun to produce drip and sprinkler systems. However, the scale is at present limited, and consequently, costs are high. Moreover, based on cursory observations, the technology being employed is also fairly primitive. Efforts to improve the capability of such firms -- and to induce such large manufacturing firms as Kirlosker Cummins International into the production of irrigation equipment -- would be worth exploring. The latter has had nearly a century of experience in manufacturing pumps and motors for irrigation on the Indian subcontinent and, from their base in Pune, they would be a logical participant in efforts to facilitate groundwater exploitation in the Deccan Plain.

The program that sought to facilitate groundwater development by making it financially more attractive also needs a research component focused on the areas in which the system installations are expected to occur. Of particular interest, for example, is the use of advanced distribution systems with the shallow dug wells that form the mainstay of groundwater development in the Deccan. The aquifer there does not support the type of continuous pumping throughout the agricultural year that characterizes the Northwestern parts of India. Consequently, the management of scarce water supplies becomes even more of an art. Locating a multidisciplinary center for advanced research on irrigation techniques -- including the agricultural enterprises associated with such techniques -- would be an obvious step in conjunction with a groundwater assistance program. Because of its location, such a project or center would be under constant "selection pressure" to produce technology that was relevant to the surrounding agricultural community. (Mahatma Phule Agricultural University on the Deccan Plain, for example, would appear to be a good choice for such activities.)

ANNEX II

UTILIZATION OF GROUNDWATER IN HARD ROCK AREAS

by

Dean F. Peterson, Budhajirao R. Mulik, Manohar M. Sawant and Jack Keller

UTILIZATION OF GROUNDWATER IN HARD ROCK AREAS

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and Jack Keller

Setting

Utilization of groundwater could be by conjunctive use in canal areas, or it could also include wells in rainfed areas. In the hard rock area, two-thirds of India, essentially the Deccan Peninsula, groundwater is limited to the weathered zone between the zone mantle and the rock, except in some areas (trap areas) where there are some deeper small aquifers lying between successive nearly-horizontal layers of basalt. In the first case, the water is developed using dug wells; for trap areas uncased bore holes are also used. Bore holes are used primarily for domestic water supply, but are also used to augment dug well supplies.

Wells in hard rock areas can irrigate only a fraction of the areas overlying the aquifer. Roughly a 10 ha tributary area is required to replenish a typical dug well which can serve only 1 or 2 hectares. The aquifer is replenished during monsoon (kharif season) and declines during rabi, so that during the hot dry season (April to June) capacity of the well drops to a fraction of its peak, so that it can serve only about 0.2 to 0.5 ha of perennials, or hot season crops. Canal irrigation increases the groundwater supply, and since this occurs during rabi, enhances the supply during the hot dry season.

In spite of its limits, groundwater is extremely important. One-half of Maharashtra's irrigated area is from groundwater. In the 87,000 ha sample area studied for the IT&M Project, about 4 percent receives well irrigation now. Estimates based on Maharashtra Groundwater Survey and Development Afency data show that this could increase to 13.5 percent under rainfed and to 20.7 percent with canal irrigation.[1] Wells permit growing of high-value perennial crops because they provide a reliable, if limited, supply during zaid (hot dry) season. During rabi the irrigated area receiving more reliable well service can be expanded to include high value seasonals or two seasonal kharif/rabi crops. Using higher technology such as trickle irrigation for the perennials, because of its high efficiency, doubles or criples the area that can be allocated to perennials.[2]

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[1] See Maharashtra IT&M Project Paper, Vol. II, pp. 4-30 to 4-33. (This is attached as Annex II.A.)

[2] "Dug Well Irrigation with High Technology in Maharashtra." Dept. of Agricultural and Irrigation Engineering, Utah State University, Oct. 1984. Included as Annex II.B.

Possible Strategies

The advantages of groundwater development are great: internal rates of return of 30 to 50 percent are likely; diversified, cash cropping becomes possible; the activity remains in the private sector and recurring cost problems are eliminated, to mention a few. The Maharashtra and Madhya Pradesh projects specify that plans, including credit packages, shall be developed for conjunctive use of groundwater in subproject areas, but this has limited potential and will evolve slowly. The problems of groundwater development include: (1) incentives; (2) financing; (3) technological improvement; (4) equity; (5) aquifer management; and (6) markets.

1. Incentives. This is largely a matter of markets and farmer perceptions of risk and payoff. Sugar mills definitely accelerate development in adjacent areas, for example. Efforts could include market development for new perennial crops; for example, grapes. Demonstrations would be included.

2. Financing. This is now private. Institutional credit is through the development banks refinanced largely through ARDC. This system does not appear to be a promising vehicle for technology transfer and ineligibility of borrowers is a serious problem. Ineligibility is frequently because of arrears, but occurs often for technical reasons such as recorded land titles or bank regulations limiting ceilings on assets than can be mortgaged. If the investment is a good risk, then there should be a way to recover it, regardless of other involvements.

A promising approach would be for the State to appropriate credit capital to the development banks with the State Development Corporation holding the mortgages on behalf of the State.[3] This would be a neat complement to the ongoing ARDC program, reaching large numbers of farmers not now served through ARDC. AID could reimburse against this expenditure, but the reimbursement should be for measured performance. Number of wells developed or area provided service could be the bottom line, but payments could be made for such steps as:

- Sanctioning the budget and assigning institutional responsibility;
- Completion of plans including credit packages, private and institutional, and plans for electrification, if relevant; and
- Completion of construction of wells.

This approach has several advantages over providing additional capital resources to ARDC. It would not be a direct capital transfer

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[3]This follows somewhat the procedure for financing projects under AD/SC in Himachal Pradesh, except that in HP the Agriculture Department rather than the banks and Development Corporation, manages the program. The HP model could be an alternative.

program, policy dialogue would be at State level where the responsibility lies and a practical vehicle for institutional development and technology transfer would be present.

3. Technology Improvement. The introduction of high-tech efficient methods of application to perennial crops has already been mentioned. Another possible area is pumping technology. A third area relates to agricultural production technology, including crops and cropping systems, and cultural practices such as fertilizer, pesticide and water optimization. A fourth area could be development of markets and farm production economics. A fifth area relates to aquifer management and includes such things as remote sensing monitoring and computer modeling.

4. Equity. Farmers holding 6 to 10 ha or more could have their own wells. About 30 percent of the farmers and 70 percent of the land area would fall in this category. What to do about the rest is more difficult because one well, and particularly the 0.25 to 0.50 ha perennial area it can serve, is not a very divisible asset. This might be relatively easy if only two owners were involved. Perhaps groups could be formed and offered shares in the enterprise. These could be sold or leased. Possibly the well and the perennial field could be operated cooperatively with each using a share of the excess rabi water on his own field, or maybe this problem should be left to the farmers' own devices.

With the high IRR and available financing, there should be no reason for subsidies, even for small and marginal farmers. Wells built from private funds should be considered for inclusion in the performance indicator, but only if they complied with GSDA well-spacing standards. These will not be included in the cash flow accounts of the State government.

5. Aquifer Management. If the aquifer is overdeveloped, then everybody suffers and the "tragedy of the commons" destroys the enterprise. Some regulation of development is needed. Well spacing criteria are included in present institutional credit packages, but there is no control over privately-financed development. The status of the model groundwater law in potential candidate States and its provisions for control against overdevelopment needs to be examined. Because GOI or no one else can guarantee State legislative action, examination needs to be given to other means of preventing over-exploitation, perhaps through some sort of district structure where well spacing could be enforced administratively.[4] Maybe there are other approaches than regulation, e.g., training and information. While the threat is there, it may be fairly remote and possibly need not be fully solved in order to have a successful project.

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[4]Water in India is regarded as State property. Perhaps the State has the right to ration it administratively. It does this for surface water under the Sejpauli system.

Collection and analyses of data about water levels and groundwater withdrawals provides the information base for aquifer management. Most States, including Maharashtra, have capable groundwater agencies.[5] There should be no problem about developing technical support, however, the efforts of that agency should be included in the performance criteria and some arrangements made so that achievement of these reward their budgets positively.

6. Markets. Market access for high-value cash crops is an important element in any groundwater development strategy. This is dramatically demonstrated in the case of sugarcane. Alternative cash crops to sugarcane and development of market infrastructure could be project elements. There are examples of success, e.g., sugar, apples (from Himachal Pradesh), etc.

Magnitude

Suppose AID targeted 25,000 ha at Rs. 30,000 per well serving 1.25 ha net plus land development costs of Rs. 10,000/ha. This totals Rs. 850,000,000, or about $70 million. With cost sharing, the project could be in the $50 million range. Groundwater development potential of the 87,000 ha included in the original 13 Maharashtra IT&M project was estimated at about 14,000 ha in addition to 4,000 ha existing already.

Other Comments

If this is "capital transfer," note, in contrast to the surface irrigation projects, that the transfer is directly into the hands of farmers. The State simply provides the vehicle. There is scope for institutional development in the credit apparatus through new activities in agricultural extension, in the groundwater development agencies and in village and community involvement in planning and management, etc. The approach has good potential for policy dialogue; the role of the State in aquifer management, for example. As far as is known, no State has passed basic groundwater legislation, although the Center has pressed for this based on a model law for a number of years. There could be administrative approaches, which would not require legislation, because States have already declared water to be the property of the State.

Another question is, what measures can be taken to prevent overdevelopment by private financing? Repayment is another example. Does the State have adequate ways to recover the costs? Equity questions are another. What mechanisms can be devised so that small farmers can gain joint access? Market development for high-value commodities and improved ways to deliver technical hardware and services are other possibilities.

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[5] These stem from the efforts of the cooperative groundwater Survey Project under TCA (AID's predecessor) during the 1950s which provided U.S. Geological Survey assistance. This is one example of a highly successful technical assistance project.

GROUNDWATER DEVELOPMENT POTENTIAL

MAHARASHTRA IT&M PROJECT[1]

Groundwater Development

The State of Maharashtra is underlain by massive basaltic and granitic rock formations. Overlying this substratum is a zone of unconsolidated material consisting of fractured rock of variable thickness. This layer usually is several meters or more in thickness and provides a free aquifer (in contrast to an artesian aquifer which is under pressure) of limited capacity. However, this limited aquifer does provide significant potential for economical exploitation of irrigation in MIPs.

Exploitation of these aquifers with tubewells is not possible because of the low water transmission capacity of the aquifer. In contrast, dug wells several meters in diameter and up to 15 to 20 meters deep are used. These yield 15,000 to 20,000 m^3 annually, enough to irrigate about 2 ha of crops. Water may be pumped by mechanical means, electric or diesel, or by using animal or human power. The extent of mechanization varies greatly. For example, more than 90 percent of the wells are modernized in Amravati District (Shahanur Subproject), while less than 5 percent in Raigad (Hetavne Subproject) west of the Ghats.

Aquifers are recharged primarily by rainfall and land development increases rainfall recharge through increased percolation. Deep percolation from reservoirs, irrigation canals and irrigated fields also adds substantial amounts. A study by Maharashtra Groundwater Survey and Development Agency (MGSDA) of more than 100,000 wells in three districts in central Maharashtra showed that wells in irrigation command areas each produced about 25 percent more water on an average than those not in command areas. In addition to increased discharge, the number of wells that can be supported in irrigation command areas is greater.[2]

Except in high rainfall areas, MIPs do not provide water for the more remunerative perennial or hot weather crops like sugarcane, long staple cotton or hot-weather groundnuts. Groundwater which can be used for such cash crops provides a very valuable complement to a farm household economy, especially to the monetary part. Conjunctive use of groundwater is thus a powerful factor in accelerating development in

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[1]From Maharashtra Irrigation Technology and Management Project, Vol. II, Ch. 4, pp. 30-33. April, 1982.

[2]During the 17 years since Khelna MIP was constructed, the number of wells in the command area increased from 144 to 304. The average area irrigated per well increased from 0.78 to 2.01 ha.

irrigation commands. Full well development within the command area will essentially eliminate any potential waterlogging hazards.

Reports of MGSDA verify that exploitation of aquifers exist in all 13 proposed subprojects, with many wells already in existence. Based on watershed level, groundwater balance information furnished by MGSDA and following their guidelines, GOM/ID have estimated (Table 1) that in the 87,000 ha CCA about 12,000 ha gross cropped area could be irrigated from groundwater alone if no surface irrigation system were built. With the establishment of MIPs this potential would be raised to 18,000 ha, or 21 percent of the CCA. At present an estimated 3,800 ha (4 percent of the CCA) is being irrigated with groundwater. Each well could irrigate about 2 ha; 0.75 ha of sugarcane and 1.25 ha of seasonal crops.[3]

These estimates are conservative because they are interpolated from average watershed data. MIP commands are in the lower parts of watersheds where aquifers will be better than average. Moreover, GOM/ID's estimates of the amount of recharge provided by irrigation are admittedly conservative; only 15 percent of the water delivered over the canal sill with 50 percent of that considered recoverable, or 7.5 percent of canal deliveries. In its Economic Analysis, USAID, as does World Bank, assumed that half of the conveyance and farm application losses as calculated from a water budget would be recoverable.

Surface water quality (salinity) in Maharashtra is generally very good. Since water in MIP aquifers is essentially recycled annually, groundwater quality is not expected to be a problem. GOM/ID, however, will supply AID with groundwater quality information on MIPs showing variation over time. ID/DIRD maintains groundwater quality and water level surveys in wells on new MIPs up until five years following initiation of construction. This will be extended on subprojects through the entire development period for up to 20 years with MGSDA collaboration as appropriate in order to provide information on recharge, groundwater use and quality changes under canal irrigation. Information on groundwater irrigation, including costs and returns, will be included in socioeconomic baseline surveys required under the project.

In order to develop and facilitate conjunctive use of groundwater, refresher training, possibly at the Staff Training College, will be provided in groundwater hydrology, well hydraulics and economic analysis of conjunctive use to mid-level officers and others responsible for subproject design. Groundwater balance studies will be made using historical data on ground and surface water use and at least two years of additional data collected after the project's implementation on at least existing MIPs, one of each in the low, medium and high rainfall zones. A report for use in planning and evaluating conjunctive use will be

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[3]This is, by convention, 2.0 ha annual gross cropped area. Actually, perennials must be irrigated all three seasons; thus, the seasonal irrigated area would be 1.25 + 3 x 0.75 = 3.50 ha.

prepared and distributed with copies to USAID not later than 27 months after the project agreement is signed. This report will be reviewed during mid-term project evaluation.

Demonstrations of conjunctive use of groundwater will be implemented on qualifying MIPs by the GOM/ID with the assistance of MGSDA. This may be done on farmers' fields utilizing existing wells on GOM demonstration farms, or as special demonstrations. Information on development of groundwater including technical information and financing will be developed and made available to farmers, agricultural officers and extension subject matter specialists in qualifying subproject areas. GOI/GOM provides subsidies of 25 percent of the costs of wells and well equipment to small and marginal farmers. AID will support U.S. training for mid-level or senior officers in conjunctive use of water.

TABLE 1

ESTIMATED GROUNDWATER DEVELOPMENT IN CANDIDATE MIPs

Potential Subproject	Cultural Command Area	Planned Surface Irrigation (in ha)[a]	Groundwater Potential		Estimated Present GW Development[b]
			WO/P	W/P	
Uramodi	6,704	9,030	1,328	2,426	372
Hetavne	7,456	12,831	1,054	2,260	40
Delni	5,242	4,353	652	844	83
Sonwad	3,890	2,362	488	616	227
Panzan	2,893	2,011	700	842	341
Khairi	2,275	2,241	414	562	184
Sina	20,522	7,214	1,922	2,202	884
Sankh	3,543	2,834	320	528	135
Bori	8,700	7,657	932	1,366	278
Shivna	8,992	7,487	1,452	1,908	783
Mun	9,755	10,770	1,222	1,756	247
Shahanur	9,332	4,175	320	954	193
Karwappa Nalla	8,048	5,252	1,238	1,668	49
TOTAL	87,352	75,317	11,842	17,972	3,816

[a]Gross cropped area.
[b]Estimated by USAID from GOM/ID information.

DUG WELL IRRIGATION WITH HIGH TECHNOLOGY IN MAHARASHTRA

A CASE STUDY

by Manohar M. Sawant and Budhajirao R. Mulik[1]

Description of the Study

Water is one of the most important inputs in agricultural production. The Indian agriculture as a whole depends mostly on the monsoon rains concentrated in three to four months of the year. As per the First Irrigation Commission of Maharashtra (2) the ultimate irrigation potential from all sources is only 40 percent of the cultivable land in that State. By the end of 1977-78 only 12 percent of potential was harnessed (7). Out of the total area irrigated nearly 59 percent is irrigated by wells (12). Only about 30 percent of the groundwater potential is now utilized. The groundwater in Maharashtra offers a wide scope and challenge to the scientists and planners to introduce high technology in its efficient utilization.

The studies (8) made by the Groundwater Survey Development Agency (GSDA) revealed that 1.8 million new wells are possible in addition to 0.939 million existing wells. The well irrigation is mostly through dug wells. The state average of area irrigated per well is 1.23 ha (12). It is possible (13) to increase the area irrigated by the wells of existing capacity with introduction of trickle and sprinkler irrigation replacing present surface irrigation.

The following is a case study which compares rainfed agriculture with dug well irrigation with present low technology and with high technology. A typical (13) annual yield of a dug well, 1481 ha-mm, is considered for the analysis. The aquifer containing the well is recharged to its full capacity by the end of the monsoon so that the 1481 ha-mm yield of the well is available for rabi and hot weather. The withdrawals from the well aquifer in kharif are readily replenished. Usually the discharge from the dug well decreases to minimum (approximately 0.2 lps or 11.52 m^3/day) in the hot weather (March-June) season. This cannot be utilized using surface irrigation. Trickle irrigation can handle such small discharges to support perennial crops such as grapes (selected for present analysis), bananas, or other fruit crops.

Surface irrigation generally has a low irrigation efficiency (approximately 45 percent) whereas efficiencies for sprinkle (about 75 percent) and trickle (nearly 100 percent in view of smaller surface wet area) are quite common.

The farmer considered for the analysis cultivates 2.9 ha. Under the high technology alternative he opts for grain crops sufficient to just meet his family needs (about 12.0 quintals of jowar (sorghum) and

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[1]Graduate Research Assistants, Department of Agricultural and Irrigation Engineering, Utah State University, Logan, Utah. January, 1985.

12.0 quintals of wheat per year) and whatever additional water he has goes for grapes and high-paying seasonal crops such as groundnut in kharif and onion in rabi. He could have selected other crops, but for the present analysis, the choice is restricted to two crops only. From the average yield data (12) of irrigated kharif sorghum, irrigated rabi wheat and rainfed sorghum, the area needed for these crops are 0.5 ha, 0.5 ha and 1.5 ha.

The other assumptions made for the analysis are summarized below:

1. Well capacity 1481 ha-mm or 12 acre-ft available for rabi and hot weather;
2. Minimum supply of 0.2 lps or 11.52 m^3/day (for 16 hr pumping);
3. Water pumped in kharif is recharged readily;
4. Full capacity of well cannot be used under present technology due to very short supply in summer;
5. Farmer opts for irrigated grain crops (sorghum [0.5 ha] and wheat [0.5 ha]) just to meet the part of his needs that cannot be met by rainfed and then goes for commercial, high paying crops;
6. Water available after perennial needs determines rabi area under high technology;
7. Area under kharif under high technology is same as in rabi; and
8. The same quantity of water is used in kharif under high technology as under present technology.

Analysis

Water Requirement and Areas

The potential evapotranspiration (ETP) values for Maharashtra tabulated by Hargreaves, et. al. (5) for Aurangabad were used along with the crop coefficients recommended by Doorenbos and Pruitt (4) to calculate the crop consumptive use. Subtracting the effective rain (7), the net irrigation requirement for each crop was worked out. Following are the tables showing the water withdrawals from the well under high technology (trickle for grapes and sprinkle for onions and groundnuts and low technology).

TABLE 1

WATER WITHDRAWAL FROM DUG WELL UNDER HIGH TECHNOLOGY

Month	Grapes (0.24 ha)	Onion (2.16 ha)	Wheat (0.5 ha)	K.Gr. Nut (2.16 ha)	K.Sorghum (0.5 ha)	Total
	ha-mm	ha-mm	ha-mm	ha-mm	ha-mm	ha-mm
Jan	20.9	367.8	100.3	-	-	489.0
Feb	25.5	120.0	119.0	-	-	264.5
Mar	33.8	-	25.3	-	-	59.1
Apr	34.1	-	-	-	-	34.1
May	29.6	-	-	-	-	29.6
Jun	1.0	-	-	-	-	1.0
Jul	-	-	-	8.6	-	8.6
Aug	-	-	-	137.4	34.7	172.1
Sep	-	-	-	161.0	32.3	193.3
Oct	13.9	2.0	-	81.0	8.7	105.6
Nov	16.6	199.3	22.0	-	-	237.9
Dec	18.6	259.2	75.0	-	-	352.8
Totals	194.0	948.3	341.6	388.0	75.7	1,947.6

Total Yield of Well: 1947.6 ha-mm
Kharif Yield: 480.6 ha-mm
Net Yield: 1467.0 ha-mm
Peak Withdrawal/month: 489.0 ha-mm
Peak Rate, m^3/day: 163 m^3/day
or 2.83 lps for
16 hr/day

TABLE 2

WATER WITHDRAWAL UNDER PRESENT TECHNOLOGY

Month	Onion (1.18 ha)	Wheat (0.5 ha)	K.Gr.Nut (1.13 ha)	K.Sorghum (0.5 ha)	Total
	ha-mm	ha-mm	ha-mm	ha-mm	ha-mm
Jan	333.0	167.2	-	-	500.2
Feb	109.2	198.3	-	-	307.6
Mar	-	42.2	-	-	42.2
Apr	-	-	-	-	-
May	-	-	-	-	-
Jun	-	-	-	-	-
Jul	-	-	7.5	-	7.5
Aug	-	-	119.8	57.8	177.6
Sep	-	-	140.4	53.9	194.3
Oct	1.8	-	70.6	14.4	86.8
Nov	181.5	36.7	-	-	218.1
Dec	236.0	125.0	-	-	361.0
Total	861.5	569.4	338.2	126.1	1,895.3

Total Yield of Well:	1895.3 ha-mm
Kharif:	465.6 ha-mm
Net Yield:	1432.0 ha-mm
Peak Withdrawal/Month:	500.2 ha-mm
Peak Rate:	116.6 m^3/day or 2.89 lps (day-16 hr)

On-Farm Income

The yields and income per hectare for the various crops selected were based on the reports of agriculture in Maharashtra (1), (3), (5), (8), (12). The income per hectare from each crop is defined as the gross value of product at farm gate prices minus selected farm costs which represents payments by or losses to the farmer such as fertilizers, chemicals, bullock costs, etc. Following is the table showing income under the high technology, present low technology and the rainfed.

TABLE 3

ON-FARM INCOME

Crop	Income Rate Rs./ha	High Tech		Present Low Technology		Rainfed (Kharif)	
		Area ha	Income Rs.	Area ha	Income Rs.	Area ha	Income Rs.
Grapes*	60,000	0.24	14,400	-	-	-	-
Onion	10,000	2.16	21,600	1.18	11,800	-	-
Wheat	2,500	0.50	1,250	0.50	1,250	-	-
K.Gr.Nut	6,000	2.16	12,960	1.13	6,780	-	-
K.Sorghum	2,000	0.50	1,000	0.50	1,000	-	-
Gr. Nut (Rainfed)	2,400	-	-	1.28	3,070	1.4	3,360
Sorghum (Rainfed)	1,200	-	-	-	-	1.5	1,800
		2.90	51,210	2.90	23,900	2.9	5,160

*For grapes:
1. First year no income
2. Second year income Rs. 7,..00
3. Three to ten year income Rs. 14,400
4. Life of vineyard 10 years

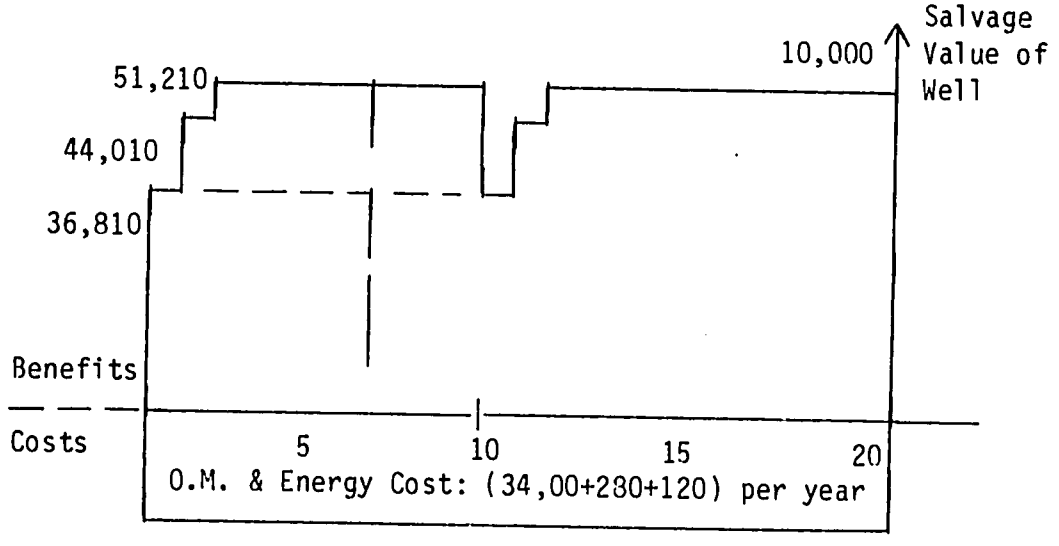
Economic Analysis

Assumptions

1. Economic analysis of 20-year period.
2. Well life 40 years, cost Rs. 20,000.
3. Sprinkler life 20 years, cost Rs. 5,000/ha.
4. Trickle life 10 years, cost Rs. 15,000/ha.
5. Installation cost of grape, Rs. 24,000/ha, 20 years, Rs. 16,000/ha every 10 years.
6. Land development:
   a. For sprinkler and rainfed: Rs. 2,000/ha.
   b. For surface irrigation: Rs. 4,000/ha.
   c. Annual maintenance in case of surface: Rs. 100/ha.
   d. Life: 20 years.
7. Interest rate: 10 percent per year.

Cash Flow Diagrams

1. High Technology

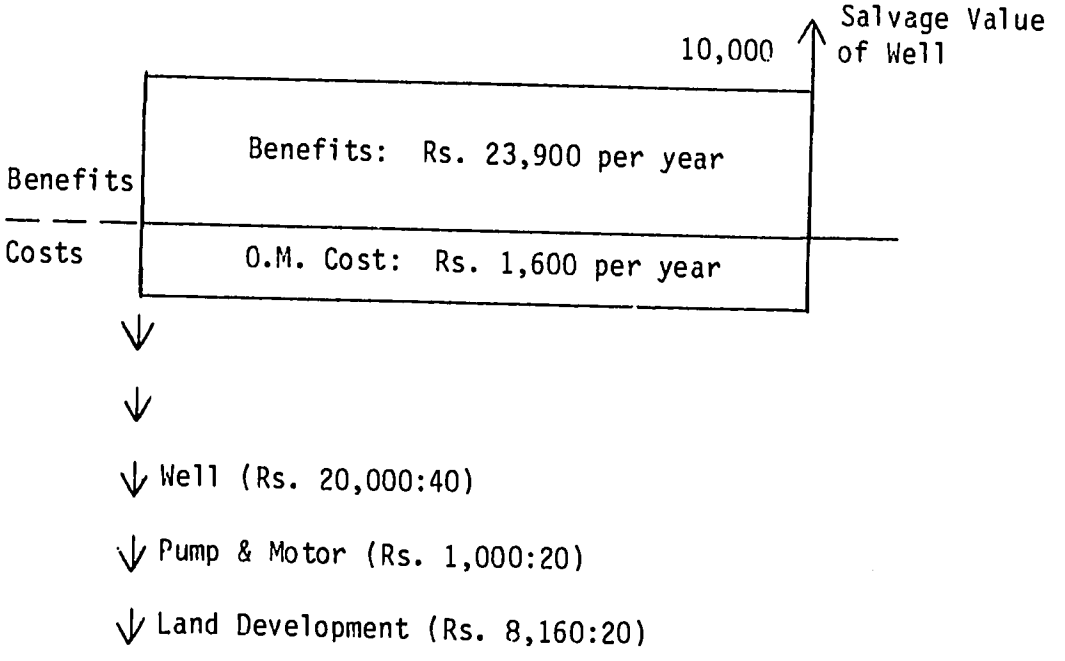


(5,760:20) ↓ Installation of grape vineyard
(3,840:10)
(20,000:40) ↓ Well
(13,300:20) Sprinkler
(3,600:10) ↓ Trickle
(5,320:20) Land Dev. (sprinkler)
(500:20) ↓ Pump (trickle)
(3,000:20) (sprinkler)
↓

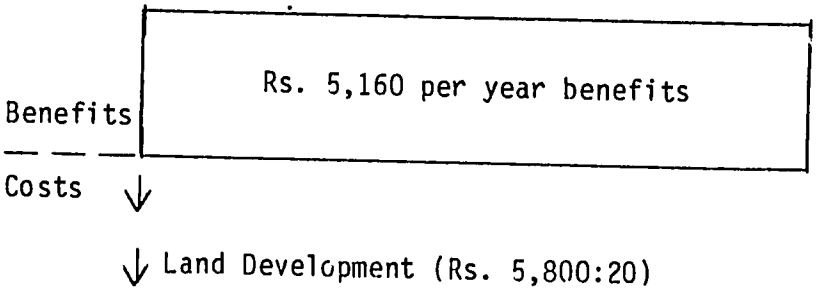
↓ Trickle (3,600:10)

↓ Replanting of grape vineyard (3,840:10)

2. Low Technology



3. Rainfed



Internal Rate of Return

Table 4, below, shows that investing in a well and using only present technology yields an internal rate of return of 72 percent over rainfed. Using high technology in comparison to low technology for the well yields an internal rate of return of 76.29 percent on the additional investment.

TABLE 4

COMPARISON OF RAINFED VERSUS PRESENT IRRIGATED TECHNOLOGY

Items	Rainfed A	Present Technology B	Diff. B-A
Well	-	20,000	20,000
Salvage value of well after 20 yr.	-	10,000	10,000
Pumps & motor	-	1,000	1,000
Land development	5,800	9,160	3,360
O.M. cost/yr	-	1,600	1,600
Annual benefits/yr.	5,160	23,900	18,740
Internal rate of return			72 %

Labor Employment

The introduction of new technology is usually misunderstood as replacement of human labor with machine power. Based on the reports 1, 3, 5, 8, 11, 12 the labor flow is estimated for the cropping scheme under high technology, present low technology and rainfed. The tables below indicate the labor flow under the three alternatives. The on-farm and off-farm employment profile is also estimated based on the reports 3 and 11.

Conclusions

1. With introduction of high technology, efficient utilization of the yield of dug well is possible.

2. The internal rate of return of present low technology over the rainfed is 72 percent and that of high technology over the present technology is 76.3 percent. Thus, the introduction of high technology dug well irrigation is economically far superior.

3. The labor employment opportunities both for on-farm and off-farm are better with high technology.

TABLE 5

COMPARISON OF PRESENT LOW TECH VERSUS HIGH TECHNOLOGY

Items	Present	High Tech	Diff.
Well	20,000	20,000	--
Salvage value of well	10,000	10,000	--
Pump & motor	1,000	3,500	2,500
Land Development	9,160	5,320	3,840
Sprinkler	--	13,300	13,300
Trickle	--	3,600	3,600
Trickle (after 10 yr)	--	3,600	3,600
Grapes fixed installation (20 yr)	--	5,800	5,800
vineyard installation (10 yr)	--	3,900	3,900
vineyard installation (after 10 yr)	--	3,900	3,900
Benefits 1st yr.	23,900	36,810	12,910
2nd yr.	23,900	44,010	20,110
3-10 yr.	23,900	51,210	27,310
11th yr.	23,900	36,810	12,910
12th yr.	23,900	44,010	20,110
13-20 yr.	23,900	51,210	27,310
Internal rate of return			76.29%

TABLE 6

ESTIMATED LABOR FLOW: HIGH TECHNOLOGY

Months	Grapes (0.24 ha) P day	Onion (2.16 ha) P day	Wheat (0.5 ha) P day	K.Gr.Nut (2.16 ha) P day	K.Sorghum (0.5 ha) P day	Total P day
Jan	50.4	64.8	2.5	--	--	117.7
Feb	50.4	226.8	1.0	--	--	278.2
Mar	39.6	--	4.0	--	--	43.6
Apr	93.6	--	--	--	--	93.6
May	86.4	--	--	30.4	4.5	121.3
Jun	19.2	--	--	43.2	2.5	64.9
Jul	7.2	--	--	28.1	2.0	37.3
Aug	19.2	--	--	32.4	3.5	55.1
Sep	7.2	--	--	6.5	3.0	16.7
Oct	91.2	365.0	2.0	90.7	10.0	558.9
Nov	14.4	64.8	5.0	--	--	84.2
Dec	26.4	97.2	3.0	--	--	126.6
Total	505.2	818.6	17.5	231.3	25.5	1,598.1

TABLE 7

ESTIMATED LABOR FLOW: PRESENT LOW TECHNOLOGY

Months	R.Onion (1.18 ha)	R.Wheat (0.5 ha)	K.Gr.Nut (1.13 ha)	K.Sorghum (0.5 ha)	K.Gr.Nut (Rainfed) (1.28 ha)	Total
Jan	35.4	2.5	--	--	--	37.9
Feb	123.9	1.0	--	--	--	124.9
Mar	--	4.0	--	--	--	4.0
Apr	--	--	--	--	--	--
May	--	--	15.8	4.5	11.5	31.8
Jun	--	--	22.6	2.5	25.6	50.7
Jul	--	--	14.7	2.0	14.1	30.8
Aug	--	--	17.0	3.5	14.1	34.6
Sep	--	--	3.4	3.0	2.6	9.0
Oct	199.4	2.0	47.5	10.0	47.4	306.3
Nov	35.4	5.0	--	--	--	40.5
Dec	53.1	3.0	--	--	--	56.1
Total	447.2	17.5	121.0	25.5	115.3	726.5

TABLE 8

ESTIMATED LABOR FLOW: RAINFED (DRY)

Month	K.Gr.Nut (1.4 ha)	K.Sorghum (1.5 ha)	Total
Jan	--	--	--
Feb	--	--	--
Mar	--	--	--
Apr	--	--	--
May	12.6	13.5	26.1
Jun	28.0	7.5	35.5
Jul	15.4	3.0	18.4
Aug	15.4	3.0	18.4
Sep	3.0	6.0	9.0
Oct	52.0	24.0	76.0
Nov	--	--	--
Dec	--	--	--
Total	126.4	57.0	183.4

TABLE 9

EMPLOYMENT PROFILE: ON-FARM AND OFF-FARM

Crops	High Tech		Low Tech		Rainfed	
	On-Farm	Off-Farm	On-Farm	Off-Farm	On-Farm	Off-Farm
K.Sorghum (Dry)	--	--	--	--	57.0	6.0
K.Sorghum (IR)	25.5	2.0	25.5	2.0	--	--
K. Gr. Nut (Dry)	--	--	115.3	38.4	126.4	45.0
K. Gr. Nut (IR)	231.3	86.4	121.0	45.2	--	--
R. Wheat (IR)	17.5	2.0	17.5	2.0	--	--
R. Onion (IR)	818.6	86.4	447.2	47.2	--	--
Grapes	505.2	60.0	--	--	--	--
TOTAL	1,598.1	236.8	726.5	134.8	183.4	51.0
GRAND TOTAL	1,834.9		861.3		234.4	

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