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USAID/INDIA'S IRRIGATION PROGRAM

What it is and where it is going

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USAID/INDIA'S IRRIGATION PROGRAM

SUMMARY

The rationale for USAID/India's involvement in irrigation and water resources is substantial and compelling. In monsoonal regimes such a India's, year-round *access to a reliable supply* of water through irrigation infrastructure is central to agricultural growth and consequent generation of rural income. India's public investments in irrigation are huge and continuing yet most systems perform below potential, leading to waste of water and financial resources and, at worst, deterioration of the resource base. The U.S. has considerable technological and institutional experience in water resource development which can be brought to bear on the cost effectiveness and systems management constraints in irrigation and water resource development in India.

Irrigation can be broadly conceptualized as the interrelation of three physical and socio-economic systems and related technical and institutional issues: a *water resource macrosystem, a water supply hydraulic system, and an on-farm or production microsystem.* Two dimensions cut across these: the interacting hydrologies of *surface water and groundwater and the various forms of public and private ownership and control.* Irrigation performance depends on the management of these systems.

The USAID irrigation/water resource program currently consists of four State-specific and one National support project totalling approximately $270 million focused primarily on small surface irrigation systems. Until recently, USAID's program rhetoric has generally been directed at the on-farm issues related to agricultural water management and its interface with the water supply system. Meanwhile, USAID's loans for the most part finance main system infrastructure. Hence, although the projects included comprehensive technology packages, *a dichotomy existed between what USAID talked about and what it was funding.* Construction also dominated much of the the USAID-GOI dialogue.

The experience of the past four years clearly indicates that *reliable main system supply is a major constraint* to sustainability and performance, and is prerequisite to downstream, on-farm development. Our analyses indicate high returns to *main system improvements and operations* which ensure reliable supply. On the other hand, initial returns to on-farm investments have been disappointing. In new systems, efforts in *initial planning and operations* can also yield high marginal returns.

With these lessons learned, and the evidence of sustained productivity from predictable water, USAID is shifting attention towards the planning, operations, and performance of the *water resource / irrigation systems*. This strategy focuses on the fundamental technical, economic and institutional aspects of surface and ground water *supply* which are prerequisite to cropping shifts for more productive use of a resource under stress.

The program is currently focused on technical and institutional improvements in public surface systems in the Indian Deccan due to initial project investments and the potential for employment generation from high-value crops in a resource-poor area. This involves improved planning, design and operations of specific irrigation systems, and concomitant professional development and research. The institutional thrust is to reorient State Irrigation Departments (the primary controllers of water) *from public works to public service* as well as to broader *planning and productivity* issues, including resource conservation, groundwater use, and non-public sector possibilities. Indo - U.S. professional exchange supported by studies and pilots will be key to this thrust.

USAID will also be looking further *upstream and underground*. Activities have been initiated in the larger water resources environment, both at regional and site-specific subproject levels. This consists of: training professionals to apply analytical methodologies to basin-wide resource allocation; professional exchange among resource planning institutions; collaboration with USAID forestry activities; and improved planning criteria, hydrological monitoring and watershed management in subproject development. Groundwater will figure prominently in this effort.

The *on-farm production system* will receive limited attention. Focus will be on water conservation through discrete technical and institutional studies and demonstrations necessary to complement the water resource and supply strategic thrusts. Possible joint-programs and agrotechnology initiatives with USAID forestry and agricultural research activities are being considered.

To implement this strategy, USAID is restructuring and consolidating its irrigation projects to better target assistance. Disbursements are being directly *linked* to systems performance indicators, rather than to construction. State projects are being consolidated into "programs" to encompass broader issues within their water resource sector. Staff is being shifted from construction and on-farm works towards planning, operations and institutional issues. Grant-funded activities are being streamlined to promote studies and technical exchange. Public and private institutions concerned with irrigation issues are being assisted in analysis of performance and management questions.

In sum, to build on past experience and investments and effectively concentrate current staff and funding levels, the Mission's strategy emphasizes program-tied assistance focused on the technical and institutional improvements necessary to ensure *reliable water supply*. The strategy targets systems management and institutional performance in water resource planning, supply and distribution for irrigation.

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INTRODUCTION

A. The Importance of Irrigation

The commonly held view of Indian agricultural development is that the sector has maintained a steady, long-run overall growth of about 3 percent per year since independence.[1] On the other hand, recent analysis indicates that the long run growth in net agriculture domestic product has been only 2.1 percent per year for the same period.[2] So, despite a current market surplus of grain in the Northwest growth in India's agriculture on a per capita basis has not been satisfactory. Indeed, Seckler and Sampath show that foodgrain availabilities are no better on a per capita basis than in the 1920s.[3]

Nearly 70 percent of India's population lives in rural areas and about 40 percent below the poverty line. In absolute numbers, the malnourished are estimated to increase by 6.4 million per year.[4] So, with a population base that will reach the billion mark by 2000, overall economic growth and the creation of massive, new productive rural employment opportunities is an imperative. Some 150 million additional people will be seeking jobs by 2000 - a 69 percent increase over 1980, and an estimated 75 million tons of additional food grain will be required merely to meet current per capita consumption level.

Given the relative and absolute size of the Indian agriculture sector, its performance will have to continue to be a basic engine of rapid economic growth. Historically economic growth has been a result of increased factor productivity.[5] The green revolution in India exemplifies this. Seckler and Sampath underscore the fact that the green revolution has been the application of biochemical, cost reducing innovations to *irrigated* land. One half to two thirds of Indian increases in foodgrain production can be attributable to production from irrigated land.[6] And almost all increases in higher-value crop production (vegetables, fruits, etc.) are predicated on irrigation. De Janvry and Subbarao unambiguously conclude that continued strong agricultural growth is a prerequisite for overall economic growth and the alleviation of the massive poverty in India.[7] They conclude that, with the expansion of cultivatible land essentially exhausted, expanding and intensifying irrigation is central and key to increasing output. Future agricultural growth will continue to depend on irrigation. Mellor, Patnaik, Seckler and others conclude the same.

With the need to increase factor productivity and maximize the returns to scarce resources, *one of the major strategic challenges facing India is that of increasing the productivity of water* used for agricultural production. In that context, increasing the effectiveness of water used for irrigated agriculture will be of most importance. This in turns translates to focusing on the reliable supplies of water for agriculture production. *Experience shows that reliability leads to increased cropped area, crop yields and, most critical for the future, crop diversification.* For example, in 1982 in Maharashtra's

Ghod project, reliable irrigation led to a per hectare annual increase in output seven times (roughly $1000) greater than production on nearby rainfed land. This was realized through area and yield effects, but most importantly from significant shifts to a mix of higher value, more labor intensive crops (from cereal grains requiring 40-80 person days to vegetables, groundnuts, cotton, bananas requiring 100-500 person days per ha).[8] Similar results are reported by Chambers[9]

Irrigation continues to be fundamental to agricultural growth in India. Given the U.S. technical and institutional experience, USAID can effectively focus resources on better husbandry of the water resource base in general, and more specifically on improving the supply and delivery of water used for agriculture. This paper reflects on USAID's current irrigation program and building on that experience, suggests a strategical frame-work for future efforts.

B. India's Irrigation Development and Potential

India's irrigated hectareage as of 1984-85, and remaining potentially irrigated hectareage is presented by state in the table below.

SURFACE IRRIGATION

AREA DEVELOPED (TO 1985) State (rank order)	('000 ha)	POTENTIAL AREA State (rank order)	('000 ha)
Uttar Pradesh	5513	Uttar Pradesh	6987
Andhra Pradesh	3017	Madhya Pradesh	4695
Punjab	2444	Bihar	4324
Bihar	2176	Maharashtra	3268
Haryana	1745	Gujarat	2252
Orissa	1508	Orissa	2092
Rajasthan	1476	Andhra Pradesh	1983
West Bengal	1475	Karnataka	1427
Madhya Pradesh	1305	Rajasthan	1274
Tamil Nadu	1225	Haryana	1255
Karnataka	1076	Assam	892
Maharashtra	1700	West Bengal	832
Gujarat	748	Punjab	556
Kerala	543	Kerala	457
Jammu & Kashmir	113	Tamil Nadu	275
Assam	78	Jammu & Kashmir	137
Manipur	26	Manipur	109
Himachal Pradesh	4	Himachal Pradesh	45

Source: Government of India, Seventh Five Year Plan, 1985-90, Vol. II. Planning Commission, New Delhi, 1985 p 88.

IRRIGATION FROM GROUNDWATER

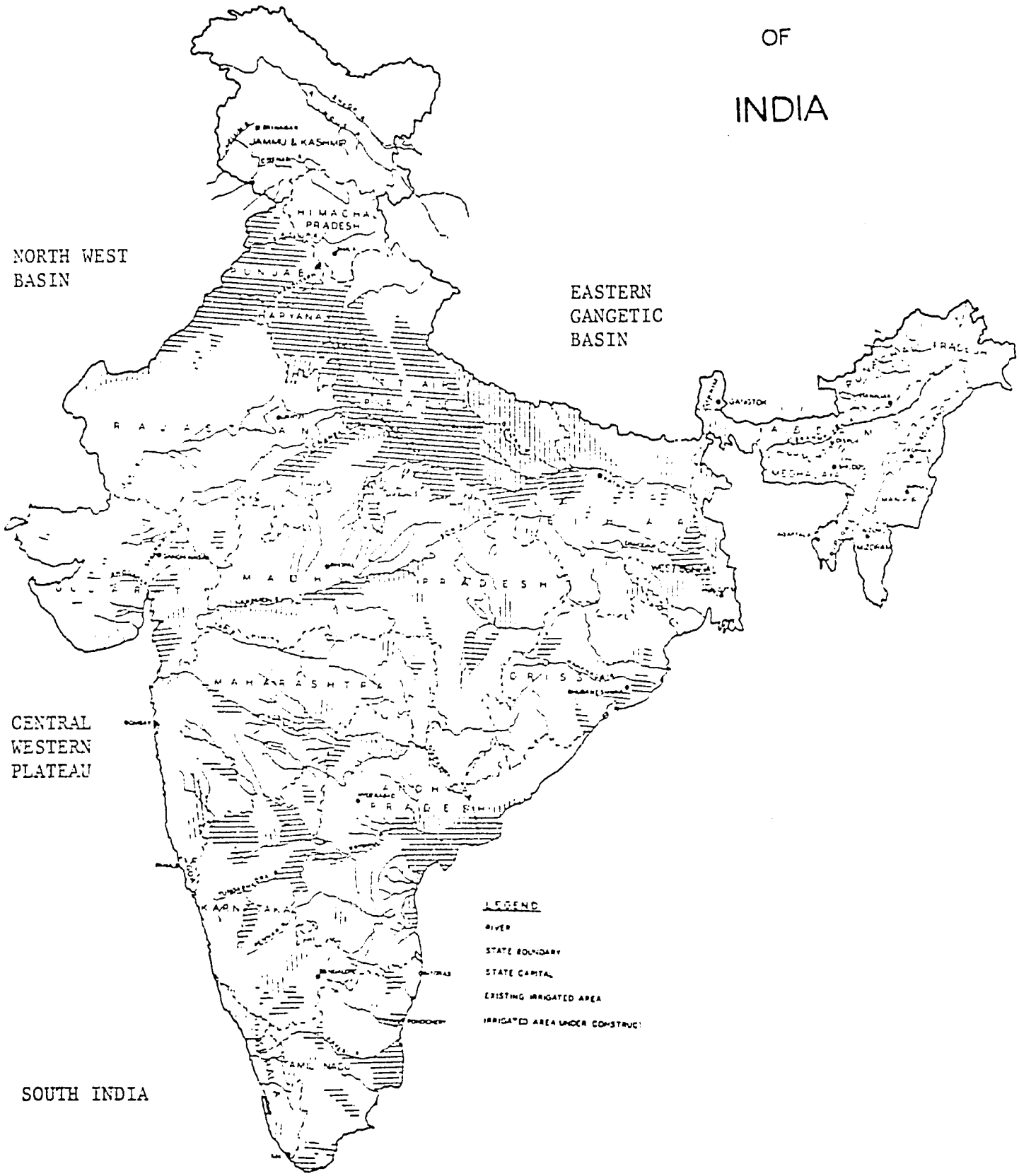
AREA DEVELOPED (TO 1985)		POTENTIAL AREA	
State (rank order)	('000 ha)	State (rank order)	('000 ha)
Uttar Pradesh	11414	Uttar Pradesh	12000
Punjab	3060	Bihar	4000
Bihar	2216	Punjab	3500
Rajasthan	1613	Madhya Pradesh	3000
Gujarat	1437	West Bengal	2500
Haryana	1366	Andhra Pradesh	2200
Maharashtra	1265	Maharashtra	2000
Madhya Pradesh	1261	Rajasthan	2000
Andhra Pradesh	1254	Gujarat	1500
Tamil Nadu	1229	Haryana	1500
West Bengal	674	Orissa	1500
Orissa	471	Tamil Nadu	1500
Karnataka	470	Karnataka	1200
Assam	91	Assam	700
Kerala	62	Kerala	300
Himachal Pradesh	9	Jammu & Kashmir	150
Meghalaya	8	Himachal Pradesh	50
Jammu & Kashmir	6	Meghalaya	15

Source: Government of India, Ministry of Water Resources ''Groundwater Development in India,'' 1986, p. 32.

India's goal is to harness the remaining irrigation potential over the next twenty years, irrigating roughly one-half of the country's cropped area. Given the seasonal, erratic and extreme nature of the monsoon rainfall pattern across India, the gains from increased surface irrigation infrastructure, in terms of more stabilized hydrology and therefore agricultural production and increases in factor productivity, are powerful arguments for continued investments. Public investments have created 20.8 million hectares of irrigation potential from 1951 through the Sixth Plan (1984). Financial requirements to achieve the remaining surface irrigation potential are estimated to be on the order of $50 billion. Groundwater development is not reflected in this figure, but accounts for nearly one half of all irrigated acreage. Although largely privately developed, groundwater is usually augmented by surface systems and command areas and also benefits from credit subsidies and rural electrification.

From the map on the following page, it can be seen where the existing surface and groundwater irrigation development has occurred (generally within hydrologic basins in the North and Northwest) and where most of the remaining potential lies: groundwater in the Eastern basins and in surface catchments of the Deccan.

IRRIGATION MAP OF INDIA



C. The Problem and Opportunity

India's irrigation and water resource opportunities and constraints are best identified and discussed in the context of four distinct water resource regions .

1. Northwest basin areas

The significant characteristics of the hydrology of these relatively arid areas (Punjab, Haryana, Northern Rajasthan and Western Uttar Pradesh) are regular surface flows from Himalayan sources and substantial groundwater in underlying alluvial aquifers. These characteristics are reflected in the level of agricultural development in these areas. Irrigated wheat yields in Punjab, for example, are about 60% higher than those achieved in Madhya Pradesh [illegible]. This is largely due to the relatively more stable and more reliable water supply provided by surface systems supplemented by private groundwater sources.

In the case of groundwater, the reliability is due to the fact that water control rests in the hand of the cultivator. Farmers can access aquifers and usually use groundwater conjunctively with rationed surface supplies. In surface systems, more regular inflows due to snowmelt, a scarce but reasonably assured supply, and the fairly widespread adoption of rationed, rotational water distribution (Warabundi) provides farmers with limited but fairly reliable supply of water.

Thus, there is a degree of certainty around which cropping and input use decisions can be made. Under these circumstances farmers in this area tend to switch to higher value, but more stress sensitive crops. These water supply systems, along with other input factors, result in over 50% of the Nation's foodgrain production supplied by this region.

2. Central and Western Deccan Regions

The central and western Deccan regions (most of Rajasthan, Madhya Pradesh, Andhra Pradesh and Maharashtra) have highly irregular and more limited supplies of both surface and groundwater. Supplies for gravity systems depend on an erratic monsoonal regime. In this area irrigation is still in an expansion phase often concentrated on new project identification and construction rather than on operations. Groundwater sources are limited and localized. Generally groundwater supply is difficult to predict. However, where surface irrigation systems provide a source of recharge, groundwater can be a significant supplemental supply.

The more limited and less predictable supply of water, and the increasingly competitive demands for it, coupled with more challenging hydrology, topography and soils, demands careful planning and management of irrigation. Given the excellent agro-climatological conditions for higher-value crops and access to regional and international markets, the returns to irrigation can be extremely high.

3. South India

The southern areas (Tamil Nadu and Kerala) have largely harnessed the available surface irrigation potentials. These States now face the challenge of managing existing systems better. Despite somewhat higher rainfall than in the Deccan, seasonal water shortages and inter-state competition for water are important issues in the region. Irrigation development in these areas is in a mature phase with emphasis on rehabilitation and better operation of existing systems as well as comprehensive efforts in water resource systems planning and management.

4. Eastern Gangetic Plains

These fertile plains (Eastern Uttar Pradesh, Bihar, West Bengal) contain major alluvial aquifers, both shallow and deep, as well as monsoon fed surface sources. Flooding and drainage are the major physical constraints. The largest unexploited irrigation potential lies here - about 12 million hectares. The deep, fertile soils, combined with the large underutilized groundwater potential in this area hold future promise for high pay offs in terms of production, employment and poverty alleviation. However, this potential remains elusive due to the complex problematic socio-economic and institutional constraints, i.e. land tenure, socio-political power structure, input delivery systems, and the under investment in roads and rural electrification.

Up until this decade, India has justified widespread surface irrigation investments primarily in terms of foodgrain self-sufficiency, relief from the vagaries of the monsoon (drought), and achieving a more geographically balanced agricultural production base. Now, as food grain production is increasingly secured, irrigation is becoming responsible for large changes in the traditional mix of irrigated rice and wheat crops to oilseeds, fruits, vegetables, spices, etc for growing urban markets at home and abroad. this change combined with the escalating construction costs and recognized lags in surface system performance is generating pressure to "intensify" irrigation development by accelerating the completion of ongoing construction, financing of smaller minor systems, improving efficiency of existing systems, expanding command area (on-farm) development, and exploring conjunctive use possibilities. Furthermore, environmental concern has called attention to the negative impacts and waste due to poor system planning and performance.

Noted Indian analysts (B.B. Vohra, B.D. Dawan, etc.) as well as senior-most officials including the Prime Minister himself bemoan the high-cost and poor performance of public surface irrigation, while stressing the need for cost-effective design, judicious operations, minor irrigation and conjunctive groundwater use. An emphasis on cost effectiveness and performance is clearly enunciated in the Seventh Plan (1985 - 1990).[11] Realism in project selection and concern over management are also increasingly evident in many State Irrigation Departments. Seckler,[12] Chambers[13] and others point to the discrepancy between the performance of surface irrigation in the

developed Northwest and the poor performance elsewhere, and the consequent potential for major improvements achievable from more dependable operations and conjunctive use. USAID is and will continue to actively, although quietly, support and implement

D. Status and Evolution of the Current Irrigation Portfolio

1. Scope and Location of A.I.D. Involvement

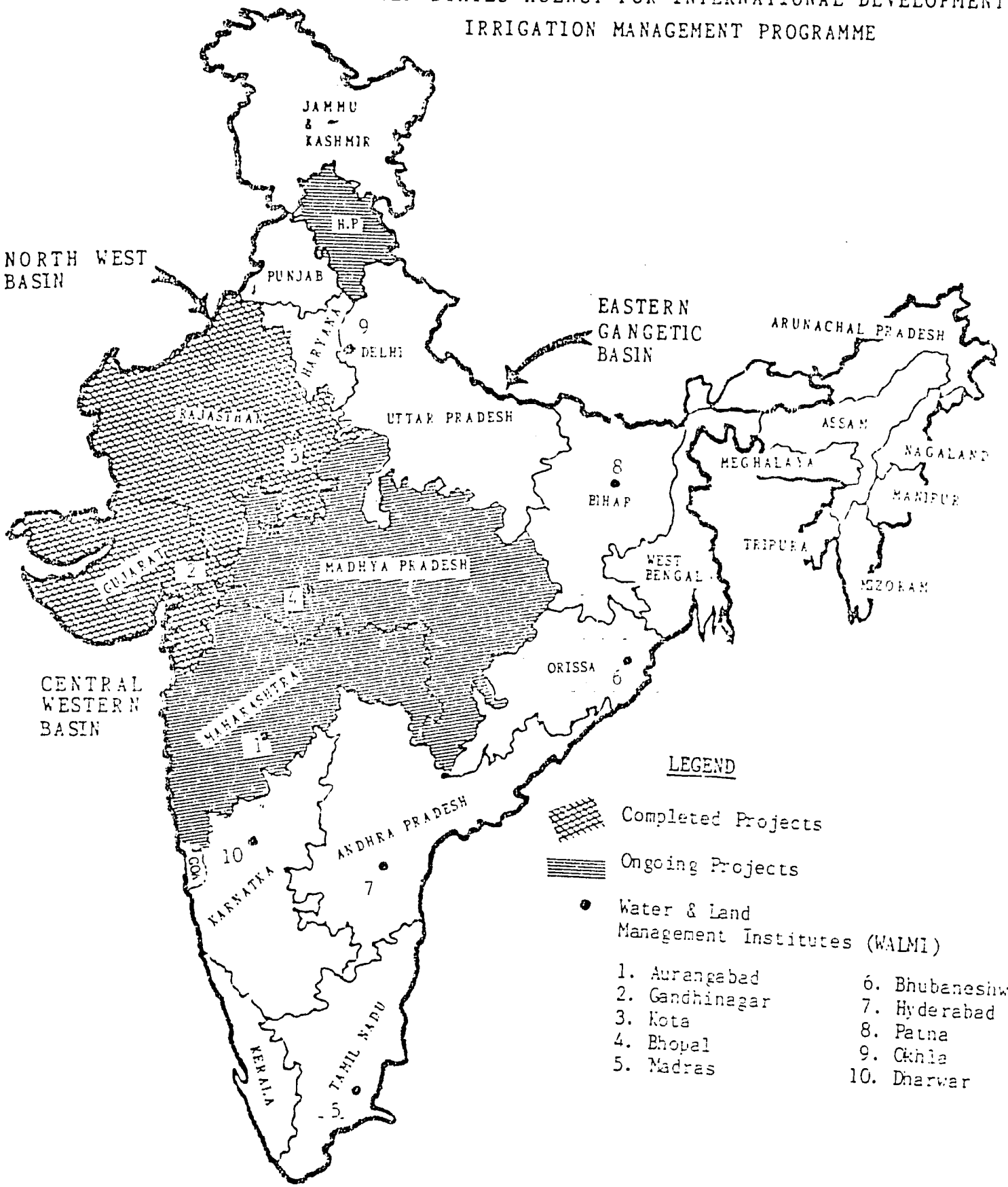
Since 1980, USAID has funded seven projects concentrated mainly in the central Deccan and dryer western areas of Gujarat and Rajasthan. Below is a brief summary and chronology of irrigation projects to date. USAID funding represents approximately 55% of the total cost of these projects.

Start Date	Project Name	USAID Funding (1000s $)		P A C D
July 1978	Gujarat Medium Irrigation	L	30,000	6/30/84
June 30, 1980	Rajasthan Medium Irr. Project	L G	35,000 1,250	6/30/86
Aug. 31, 1982	Maharashtra Irrigation Mgt. & Technology Project	L G	44,000 3,250	03/87
July 30, 1983	Madhya pradesh Minor Irrigation Project	L G	41,000 5,000	09/89
July 31, 1984	Maharashtra Minor Irrigation Irrigation Project	L G	46,000 4,000	09/90
July 31, 1984	Hill Areas Land and Water Development Project	L G	50,000 4,000	09/91
	T O T A L S	LOAN GRANT	236,000 99,250	
	GRAND TOTAL		335,250	

A review of the financial performance status and pipeline of the portfolio are presented in Annex II.

The Map on the next page shows the location of the USAID Projects.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
IRRIGATION MANAGEMENT PROGRAMME



2. Background

First, it is critical to this discussion to understand that water resources and irrigation in India are of a scale and complexity unparalleled in any country which USAID assists. India already irrigates more land than *all* of the other countries in the ANE Bureau combined. Planned GOI investments in irrigation for the Seventh Five-Year Plan *total $13 billion*. Also, irrigation development is implemented and largely financed by 22 difference State governments; the Central government only provides general guidance and financial assistance, except in major inter-State projects. Therefore, USAID, despite the relative size of its irrigation portfolio, is a minor, supporting actor on an enormous and diverse water resource stage.

USAID's involvement in public, surface system development in the Western and Deccan areas initially responded to the GOI's desire to more rapidly exploit the potential of medium and minor projects in these drought-prone areas. The 1978 Linblom Report[14] and subsequent 1981 Water Management Synthesis Project report on irrigation development options indicated that a combination of better designs and improved management of systems could at least double current irrigated crop yields in these areas.[15] this premise is corroborated in a pilot area of the large Nagajunasagar project, in Andhra Pradesh where better operations, specifically the integration of main canal operation, development of water budgets, earlier release of water, intermittent water deliveries, and other management practices, has over three years lead to average paddy production increasing from 3.5 tons per ha to 6 tons on 52,000 more hectares (27 percent increase) with 20 percent less water. In addition, large a second crop of blackgram on 15,000 ha is being planted where none had been cultivated previously.[16]

The State projects in USAID's portfolio were primarily developed to introduce, adapt and demonstrate the improvements in public surface system efficiency achievable by using vigorous economic and design standards, complete on-farm development and increased farmer participation. A brief description of these design criteria is contained in Annex II. Since 1983 the portfolio shifted from working with the larger medium irrigation systems (2,000 to 10,000 hectare command areas) to smaller minor (below 2,000 hectares), and even "micro" schemes given the shorter construction and maturation period of the latter and the opportunity for farmer involvement that these provided.

The Irrigation Management and Training Project was also developed to backup these improvements by strengthening irrigation management capacity primarily through targeted state training institutions. It was intended to support training and action research for the institutional changes and technical and management skills necessary to complement the physical design and operations improvements introduced through the State projects. Increasing concern for watershed issues and for the closer integration of management of water source, supply, distribution, and application components, let to an integrated design for the Hill Areas Land and Water Development Project.

The micro-scheme and small watershed context in Himachal Pradesh provides a useful laboratory for testing and adjusting institutional, and technical approaches to water resource development and management.

Thus, it can be seen, that there has been a gradual but significant evolution in project composition based on experiences in the field and closer working relationships with the GOI/States. Grant-funded software activities have increased; the institutional and demonstrative effects of smaller schemes were stressed; and a broader view of the water resource system developed

3. Principal Conclusions and Lessons Learned

The projects' basic "design criteria" which emphasized improved technical and operational design was not incorrect. However, project staff concentrated on the financial and construction demands of numerous subprojects which overwhelmed dialogue on the criteria, system development and performance, and the institutional structure, procedures and policies necessary to complement it.

There is generally a difference in focus between the loan assistance on main irrigation systems and the Irrigation Departments (whose primary responsibility is above the public outlet) and the grant assistance largely on lower system and on-farm activities and different sets of institutional actors (i.e. Agricultural Departments, Farmer Organizations and Universities). Relatively less grant support has been aimed at strengthening systems planning and operation to improve reliability.

CONCLUSIONS, lessons learned

Close involvement and working relationships between the local USAID Project Officers (who also act as technical advisors) and the Irrigation Departments in Madhya Pradesh and Maharashtra seem to have surprisingly significant effects on Department leadership on the importance of improving system design and operations. Collaboration and professional respect is the key to dialogue and can make local advisory assistance highly effective.

Implementation of grant-funded activities, and in particular a number of small, but important studies and pilots have been problematical due to State budgetary constraints. State and Central Government departments have difficulty ensuring priority for many of these and fail to allocate budget accordingly. As studies and pilot are key to change, extra budgetary modalities to carry them out are being identified.

Comprehensive economic analysis of the impact and contribution of irrigation development on incomes and employment is needed, particularly with respect to changes in hydrology/land-use, infrastructure/technological costs and management/delivery alternatives. Ex-post analysis of public surface irrigation projects have simply not been conducted. One World Bank paper estimated ex-post returns of 12-14 percent on four large projects.[17] Other indicators are variable or incomplete, but generally show high returns to irrigation by pumping (particularly in irrigated commands) and to operational improvements in surface irrigation systems.

Most public surface irrigation systems in India are "supply-constrained", i.e. the supply is inadequate for intensively irrigated crops over the entire command area selected. This politically-induced reality leads to two important premises: the Irrigation Departments must ration public water, therefore operational performance is crucial; and, intensified irrigated cropping patterns are only possible through highly reliable surface operations or conjunctive use by pumping from canals, drains or groundwater.

CONCLUSIONS, lessons learned

The effects of conjunctive groundwater use and changes in surface system operation on production and cropping mix are not well understood not quantified. In many of the subprojects there appears to be substantial increases in wells and changes towards higher-value crop mixes which would greatly improve rates of return resulting from lower than anticipated utilization.

Water resource and land use issues figure increasingly in subproject planning. The State projects, and in particular in Himachal Pradesh, confront watershed and competitive use constraints. The hydrological planning for surface systems (watershed yields and water budgeting) has moved us towards watershed, water resource and allocation issues for which the Irrigation Departments are asking for assistance.

In the few instances when short-term U.S. technical assistance has been possible it has generally been effective working with the Irrigation Departments on technical problems. it is, however, difficult to deliver. The Central government's clearance of foreign consultants has been a principal problem. Linking U.S. firms with Indian counterpart firms appears to help.

4. Accomplishments

First, it must be noted the even the minor irrigation systems (less than 2,000 ha) require at least three to four years for construction and perhaps six to ten years to reach operational maturity. None of USAID's projects are that old. This fact was optimistically down played in the Project Papers. It is however, still possible to point to a number of accomplishments which, while important, are obviously partial since the ultimate pay-offs are yet to be realized:

ACCOMPLISHMENTS

Irrigation management concepts and applications are now considered and discussed widely in India -- at the Center, in the States and, over the past three years, in over 200 conferences/seminars -- whereas in the 1970s this subject was of limited interest. USAID's concern and involvement has clearly helped stimulate this and continues to shift dialogue to planning and operational performance issues.

More rigorous economic and technical appraisal has been adopted for medium and minor irrigation development in the five states where USAID is, or has been, involved. Prior to that, little or no attention was given to vigorous analyses for minor and, in some cases, medium projects. In Maharashtra and Rajasthan these standards and criteria were extended to all new medium schemes, and in Madhya Pradesh to all new minor schemes, not just those receiving USAID support.

Irrigation planning and management training is being funded by Irrigation Departments in ten states, in response to the joint effort of the World Bank and USAID. Comprehensive manpower planning and improvement studies are being taken up in three states. Previously, almost no training was systematically planned or provided to irrigation officers.

Farmer involvement is on the policy discussion agenda at both Center and state levels and the subject of numerous meetings and seminars. The Government of Rajasthan is reviewing its entire water code to incorporate provisions to legally cover water user organizations. The Government of Maharashtra is actively encouraging the formation of water user cooperatives/associations. USAID has directly promoted and stimulated this interest.

ACCOMPLISHMENTS

Increased emphasis is on institutional strengthening in Himachal Pradesh, Maharashtra and Madhya Pradesh. Grant assistance has been requested and is being programmed to directly strengthen the central design organizations in the Irrigation Departments in two of those States. This establishes a critical design organizations in the Irrigation Departments in two of those States. this establishes a critical institutional link between the learning acqu'. .d in USAID assisted projects and the broader work of Irrigation Departments.

Under the IM&T Project, curriculum and training program development assistance is now to be provided to a ten-state network of irrigation management in-service training institutes (WALMIs) rather than the five originally identified in that project.

II. The Irrigation Strategy

From the preceding discussion of India's needs and the conclusions from USAID's present assistance, the following defines the objective, direction and content of the irrigation strategy.

A. Strategy Objective and Focus

The broad objective of the USAID Program is to increase and sustain the productivity of India's surface and ground water resources primarily for irrigated agriculture. To accomplish this objective, USAID's irrigation activities and resources will be focused on specific proolems/opportunities within each of the three sub-systems of irrigation. In order of priority these are as follows:

Water Supply Hydraulic System:
Reliable Operations through Technical and Performance Improvements and Institutional Reorientation.

Water Resource Macrosystem: Analysis and Planning through *Technology Transfer and Institutional Development*	On-Farm Microsystem: Conservation through Demonstration and Technology Spread.

These three areas offer important, but different targets for concentrated USAID effort:

Providing *reliable irrigation water supply* through better planned, designed and operated surface and groundwater systems is a precondition for growth in agricultural productivity and can enhance the resource base;

Better understanding and *allocation of water resources* is increasingly necessary for continued development in the face of mounting population and economic pressures and resultant competitive uses;

Surface *water and moisture conservation* from watershed to farm field is important for crop production and critical to enhancing and preserving the land base necessary for sustainable growth; and

Groundwater use is increasingly vital to guarantee, supplement and expand water supplies for irrigation production, as topographical, economic, social and environmental constraints limit further development of surface sources and sites.

B. Water Supply Hydraulic System: Reliable Operations

Dependable irrigation water can be achieved in many ways over the range of various gravity and lift (and combination thereof) systems. For dependable supply, there are two sets of institutional issues: the competence and accountability of the supplier organizations, and the forms and levels of farmer organization and control. Supply and delivery also involves a wide range of technical issues which multiply in complexity with scale, from individual small pumps to sophisticated analysis and modeling for large systems.

Studies cited earlier indicated the potentially substantial returns which can be attained from not only simple changes in operations, but from planning and designing a system to suit those operations. Since USAID is already engaged in substantial surface water development program in two large states in the Indian Deccan, the greatest concentration of staff effort and project resources in the near term will be directed at *accelerating and reinforcing improved irrigation systems planning, design and operations in these existing state projects.*

The focus will be primarily on smaller (minor) irrigation in the Deccan for several reasons: minor systems and their development are more responsive to change due to their smaller size, simplicity and speedier implementation; minor systems appear to yield good returns due to the responsiveness to beneficiaries and secondary water conservation benefits; irrigation in the Deccan is fundamental to the nascent "revolution" to high value crop mixes there; and, USAID has already gained experience and credibility with the problems and institutions in the region.

The program will emphasize changes in State irrigation Departments (currently the primary suppliers of water) and other relevant institutions necessary to (a) apply planning, design, and operation improvements to USAID-assisted schemes, demonstrations and pilots, (b) to monitor and internalize the results, in order to assess and understand the efficiency and reliability benefits and advantages, and (c) to institutionalize more rigorous operational design and planning improvements. Institutional reorientation from administering public irrigation works to planning and providing irrigation services will be the underlying theme. Given that the USAID-assisted systems are only a small fraction (less than 5%) of the States' total medium and minor system development, the potential spread effects of USAID inspired improvements is considerable.

System development will be complemented by a range of primarily grant-funded efforts (a) improve State irrigation cadre and organizations through in-service training, manpower assessments, monitoring units, and special studies, (b) to develop and test new methodology and technology through special studies, pilots, applied research at key irrigation institutions, and (c) to strengthen other institutions and groups relevant to irrigation performance (private firms, NGOs, groundwater boards, etc.) through seminars, studies and research grants. This

will in turn raise and expand the levels of institutional and policy dialogue of irrigation and water resource issues.

Equally important are the technical and institutional opportunities to understand, improve and encourage groundwater supply systems in and outside of the public sector. analysis and study will be initiated in conjunctive use planning within surface systems, system level groundwater mapping and monitoring, needs of groundwater agencies/ organizations, and policies to stimulate groundwater development.

C. Water Resource Macrosystem: Analysis and Planning

In monsoonal climatic regime with rapidly increased land use and population pressure, knowledge and informed use of the water resource is a necessity at both micro and macro-levels. As competitive industrial and domesetic demands increase (5% now to an estimated 25% of surface water supplies by 2000) water resource issues will become an increasingly complex and contentious. Water resource analysis and planning ranges from preliminary investigation of the hydrology and water use at subproject sites to resolution of basin-wide allocation issues. The interactions of surface and groundwater hydrologies also figure prominently in these systems analysis and planning efforts. A variety of institutions are involved including Central Commissions, Boards and Ministries and State Irrigation, Command Area, Groundwater and Planning Authorities.

In the USAID irrigation program, this thrust represents a relatively small portion of the overall program resources, but has broad implications for the States and the Nation as a whole. It consists primarily of two efforts: (a) improvements in micro-level water resource planning applied through guidelines for scheme appraisal and complementary dialogue at the State level, and (b) a major training initiative in macro-level water resource systems analysis and planning with the Central Water Commission and Ministry of Water Resources.

At the micro-level, the irrigation schemes proposed for USAID assistance will include analysis of the larger watershed/ water resource system. Hydrological and sedimentation monitoring and analysis, modern remote sensing and interpretation, land use considerations, up and downstream present and future uses, groundwater impacts, flood control, and competitive demands on supply will become part of the subproject appraisal and increasingly important in the program. Special studies on sedimentation rates, watershed yields and water balance modeling will help to improve these guidelines. Furthermore, water resources planning will also be a focus of subproject and state-level dialogue.

The macro-level effort in basin planning currently consists of establishing a National and State water resource planning and management capability through training with the Central Water Commission and State Irrigation Departments. Basic analytical course work, sophisticated methodologies, computer applications, and actual basin planning case studies will be taught. Other elements of this thrust are participation by

USAID in relevant water resources planning and management for a professional/technical exchange with experienced U.S. planning institutions, and close collaboration with USAID/forestry (RM) planning activities.

Substantial need also exists to improve capabilities in ground water systems analysis and planning. Given the National interest in increasing cost-effective, reliable irrigation coverage, and the large unexploited groundwater resources of the Ganges, this implies shifting some of our irrigation resources to problems and opportunities of Eastern India. The State and Central Groundwater Boards will be key to this initiative.

D. On-Farm/Production Microsystems: Conservation

The interaction of water on soil and crops (or for that matter with any other end uses) is of course basic to production. It is also critical to long-term sustainability of the resource base. Conservative management of water on-farm increases both productivity and sustainability whether within or outside of irrigation commands. This is equally true for other domestic or industrial end uses: conservation is productivity.

However, these microsystems are in the first instance totally dependent on the prerequisite of a water supply. Furthermore, although basic principles of soil-water management are well-known, their applications are particularly site specific and diverse ranging from public rainfed watershed lands to intensively cropped irrigated bottom lands. Further complexity arises from the enormous, disaggregated numbers of land user-managers and their various individual motivations and interrelated effects on the soil and water.

Few institutional relationships and tested technology/management packages are at hand to enable a major thrust to alleviate current constraints. Therefore, effort in this area will for the present be limited primarily to discrete studies, pilots and specific training and demonstration activities critical to development of particular model subprojects (e.g. upstream catchment protection, land leveling, sprinkler systems, etc). This is, however, of particular importance in Himachal Pradesh where due to the small size of the irrigation systems and vulnerable environment, on-farm issues become prominent. Coordination and even joint-project management with other USAID agricultural research (On-farm Water Management Subproject) and forestry activities are also important. There are also interesting opportunities for agro-industrial initiatives. But generally, such farm-level activities will remain a subtheme in the irrigation program, with the major effort concentrated on the prevailing problems of main systems reliability.

III. STRATEGY AND PROGRAM IMPLEMENTATION

A. Steps being taken to Adopt a Program Approach

USAID's approach to implementing the strategy will move beyond managing the portfolio as a set of discrete irrigation projects. Rather, a program approach is evolving which provides a more flexible framework for concentrating existing, and new resources against the critical strategic areas. It reflects an increased focus on underlying technical, institutional, and policy issues (versus the achievement of physical targets). It will also provide a means for the Mission to build on opportunities generated through the original projects and to continue movement on these opportunities even after the original projects reach their PACDs.

To implement the Program approach a number of steps are being, or will be taken:

1. Establishing State Programs:

In States, where USAID currently has projects, opportunities for using those activities to build institutional and other "horizontal" program-level strategic interventions are beginning to be exploited. (e.g. Maharashtra - assistance in strengthening the central staff training and design organizations at Nasik. Madhya Pradesh - support manpower of assessment and induction training). The specific mix of Program targets and supporting activities are being sorted out in these States and the sources of funding (State project, IM&T or other) to move the strategy forward is being decided. Specifically:

A Maharashtra Program Assessment (to include the two State projects plus an IM&T project component), scheduled for Summer 1987, will lead to a formal State Program;

In Madhya Pradesh a general profile of irrigated agriculture has been developed (statistical data compiled, private sector study performed) and a program will be established later in 1987;

In Himachal Pradesh, high-level discussions have been initiated at the Mission and in the State to restructure the institutional arrangements for strengthening participation and interdisciplinary, comprehensive subproject planning and implementation in the Hill Areas Project; and

a joint GOI/USAID internal review of IM&T has been completed and mechanisms are being developed to make this project more responsive and complementary to each State Program. In addition to strengthening USAID's assistance to the States where our major projects exist or have been completed (Gujarat and Rajasthan), IM&T now includes initiatives in training and research in Tamil Nadu, Bihar, Orissa, Uttar Pradesh as a result of collaborative arrangements worked out with the GOI and the World Bank.

2. Targeting and funding:

As agreements emerge at the State and Central levels on specific targets and anticipated achievements of the USAID assistance programs, "triggers" and benchmarks are being established and existing State project and IM&T funds are being linked to these. A combination of additional mechanisms will be used to direct resources toward opportunities in priority program activities.

Deob-Reob will be used to adjust and re-allocate existing funds in response to program need.

a portion of the OYB funds allocated to the Bureau's ISPAN project will be used to fund short contracts or subgrants.

PROAG amendments may be sought in the case of existing projects to extend, expand and/or further fund activities.

A core Program support project may be developed to fill in gaps or expand on opportunities generated through Program activities.

3. Performance Evaluation:

Monitoring, assessment and synthesis of progress and achievements of the State Program will continue to review, document and build on results, reassess objectives and targets, and make adjustments and modifications as conditions and opportunities change. The Program and Strategy review function will be carried out in part through review groups consisting of private experts, select public representitives together with USAID staff, and notable Indian specialists (on retainers and through a local IQC-like contact).

4. Orientation of USAID Staff:

USAID's Irrigation Office and Divisions have redefined job functions as Program Managers for individual States. As part of this role, they are required to look beyond the original projects; scopes to the underlying institutional and policy challenges within the State; and to orient project resources to deal more directly with those which are critical to implementing this Strategy's principal elements.

5. Collaboration with other Donors:

Opportunities to build upon activities of the World Bank, and to lesser extent of other donors, are regularly discussed (e.g. WALMIs, induction training in Maharashtra, system design criteria, and basin planning in Orissa). The Mission and the World Bank perceive significant advantages in coordinating activities, given the shared objectives in irrigation including institutional strengthening for planning and irrigation system operations. The program approach will seek to flexibly employ USAID resources to complement the World Bank's capital assistance. Furthermore, we will share analytical work on technical, economic and policy issues and seek to reinforce common institutional and policy themes in our dialogue with specific State and Center organizations.

B. Expected Impact from the Irrigation Program and Strategy

Sound, documented analyses and institutional adoption of efficiency and reliability improvements in irrigation systems derived from USAID-assisted medium and minor irrigation schemes and supported by institutional changes (e.g. formal decisions by Irrigation Departments to extend use of design criteria to all projects; O&M cadre strengthened; water delivery planning and performance measurably improved, etc.)

Expected Impacts

Spread of irrigation system performance improvement, experience and techniques to other States through reciprocal visits, case study documentation and training programs.

Measurable productivity and economic impact gains from investments in irrigation infrastructure resulting from improved water reliability.

Significantly better water resources analysis and planning by institutions and programs at the Center and the States to improve utilization of scarce water resources under intensifying pressures.

Continued expansion and intensification of groundwater use encouraged through supportive policies, technologies and programs.

Leading Indian institutions and programs linked and interacting with other National, U.S. and International counterpart institutions on mutually relevant water management and resource issues.

Policies and models for improved and sustained water resource management and for beneficiary involvement in irrigation scheduling, maintenance and finance are analyzed, tested and refined through strengthened local research entities.

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IRRIGATION DESIGN CRITERIA

A summary listing of the "criteria" for USAID for the State Projects in Maharashtra, Madhya Pradesh and Himachal Pradesh as shown in the Project Papers. Asterisks indicate those of most importance.

Identification

Economic/Financial

* IRR=12% (9% in tribal areas)
. "Standardized" cost estimating (Nat'l. Norms)
. Construction complete within prescribed time.

Social

. 75-85% small farms (less than 2.5 Ha.)
* Socio-Economic & administrative surveys

Source/Collection

Hydrology

* Plans for improving catchment
. Catchment yield based upon 75% dependable rainfall
* Develop and use water balance models (Water in - out)
. Monthly water supply based upon 20-yr reservoir study
* Rain and streamflow gauges installed and monitored
* Siltation rate based upon sedimentation study (Use avg. 238m/Km)
. Well Supply : Test pumped for yield

Headworks/Dam

. CWC Norms for design
* Construction quality control/monitoring

Supply/Distribution

"Main" System

* Flow Measurements at Headgate/Regulator
* Plan of Operation
. Use of regulating reservoirs

Canal Design and Construction: All

. Size based upon:
  . Peak 24-hr crop-water requirement
  * Command at 50% capacity
* 15 cm of "Hydraulic" head over field level
* Lining when justified by seepage rates (lost H_2O, hence area)
. Control gates as necessary to ensure hydraulic head, rotation, etc.
. Cross-drainage structures as necessary
* Design from tail reach to head

Minor and "Micro" System

* Layout based on:
  1:2000 topo mapping with 20 cm contours
  soil survey - capability map
  review with farmers
* APMs or gated outlets at 8 Ha. chak
. 1 Cusec discharge
* Rotational supply schedule
* Farmer maintenance after "X" years

Drainage

* Capacity to evacuate 5-yr maximum rainfall intensity

Groundwater

* Plans for conjunctive use
. Promotion of credit for shallow well development
* Monitoring groundwater level

Application/On-Farm Management-Use

* Demonstration chaks in each system
. Field channels to farm gate
. Fortnightly cropwater requirement with recommended crop pattern
. Agriculture Department assistance for land leveling
* Metrological Stations in Command Area.