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PROJECT APPRAISAL REPORT (PAR)

1. PROJECT NO.	2. PAR FOR PERIOD:		3. COUNTRY	
386-11-120-368.1	7/1/71	TO 6/30/72	India	FY 73-7

4. PROJECT TITLE
Soil and Water Management - Mysore (Project Terminated)

6. PROJECT DURATION: Began FY 1968 Ends FY 1972	7. DATE LATEST PROP	8. DATE LATEST PIP	9. DATE PRIOR PAR
	6/17/69	12/28/70	10/21/

10. U.S. FUNDING	a. Cumulative Obligation Thru Prior FY: $ 519,000 FY 72	b. Current FY Estimated Budget: $ —	c. Estimated Budget to completion After Current FY: $ —

11. KEY ACTION AGENTS (Contractor, Participating Agency or Voluntary Agency)

a. NAME	b. CONTRACT, PASA OR VOL. AG. NO.
Soil Conservation Service	PASA No. NESA(AF)-12-68

I. NEW ACTIONS PROPOSED AND REQUESTED AS A RESULT OF THIS EVALUATION

A. ACTION (X) USAID	A. ACTION (X) AID/W	A. ACTION (X) HOST	B. LIST OF ACTIONS	C. PROPOSED ACTION COMPLETION DATE
			The attached report substitutes for a regular PAR for the period 7/1/71 to 6/30/72.	No action required since project phased out on June 30 1972.

D. REPLANNING REQUIRES REVISED OR NEW ☐ PROP ☐ PIP ☐ PRO AG ☐ PIO/T ☐ PIO/C ☐ PIO/P

E. DATE OF MISSION REVIEW: March 13, 1973

PROJECT MANAGER: TYPED NAME, SIGNED INITIALS AND DATE: Kevin T. Pulard KTP 3/13/73

MISSION DIRECTOR: TYPED NAME, SIGNED INITIALS AND DATE: Howard E. Houston

Return to Bob Mueller

REPORT U-446

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PROJECT APPRAISAL REPORT (PAR)

1. PROJECT NUMBER	2. PAR FOR PERIOD	3. COUNTRY	4. PAR SERIAL NO.
386-11-120-368.3	7/1/71 TO 9/30/72	India	FY 73-9

5. PROJECT TITLE: Soil and Water Management - Punjab (Project Terminated)

6. PROJECT DURATION: Began FY 1969 Ends FY 1973	7. DATE LATEST PROP	8. DATE LATEST PIP	9. DATE PRIOR PAR
	6/17/69	7/24/70	10/21/71

10. U.S. FUNDING	a. Cumulative Obligations Thru Prior FY: FY 72 $447,000	b. Current FY Estimated Budget: $ -	c. Estimated Budget to completion After Current FY $ -

11. KEY ACTION AGENTS (Contractor, Participating Agency or Voluntary Agency)

a. NAME	b. CONTRACT, PASA OR VOL. AG. NO.
Soil Conservation Service	PASA No. NESA(AJ)-8-69

I. NEW ACTIONS PROPOSED AND REQUESTED AS A RESULT OF THIS EVALUATION

A. ACTION (X) USAID	A. ACTION (X) AID/W	A. ACTION (X) HOST	B. LIST OF ACTIONS	C. PROPOSED ACTION COMPLETION DATE
			The attached report substitutes for a regular PAR for the period 7/1/71 to 9/30/72.	No action required since project phased out on September 30, 1972.

D. REPLANNING REQUIRED REVISED OR NEW: ☐ PROP ☐ PIC ☐ PRO AG ☐ PIO/T ☐ PIO/C ☐ PIO/P

E. DATE OF MISSION REVIEW: March 13, 1972

PROJECT MANAGER: TYPED NAME, SIGNATURE, INITIALS AND DATE: Ervin T. Bullard 7/1/72

MISSION DIRECTOR: TYPED NAME, SIGNATURE, INITIALS AND DATE: Howard E. Houston

Appraisal of Soil and Water Management Pilot Projects in India

April 1972

by

Technical Assistance Bureau
Agency for International Development

and

The Soil Conservation Service
U.S. Department of Agriculture

for

The Soil and Water Management Division
Office of Agricultural Development
USAID/India

FOREWORD

At the request of USAID/India, a three-man team was organized by the Technical Assistance Bureau of A.I.D. and the Soil Conservation Service of USDA to make an appraisal of three Soil and Water Management Pilot Projects in India being conducted by the Soil Conservation Service under a participating agency service agreement with A.I.D. The team was requested, as a major aspect of their appraisal, to address the problem of how the experiences gained in the pilot projects might be applied to very large areas of the irrigated lands of India.

The team was made up of

Dr. Milo L. Cox, Deputy Director
Office of Agriculture
Technical Assistance Bureau
AID/Washington

Dr. A. Alvin Bishop
Senior Water Management Specialist
Office of Agriculture
Technical Assistance Bureau
AID/Washington

Mr. Fred A. Prange
SCS Consultant
Former Assistant Administrator for
Foreign Programs
Soil Conservation Service
Washington, D. C.

The following report briefly describes the team's findings and recommendations following six weeks of briefings, conferences, travel, inspection and study. Invaluable assistance was provided by USAID personnel, technicians of the pilot projects -- both U.S. and Indian -- Ministry of Agriculture officials and officers of the State Departments of Agriculture in Mysore, Uttar Pradesh and Punjab.

Milo L. Cox
Team Leader

TABLE OF CONTENTS

A. INTRODUCTION

1. Initial Briefings *

Immediately upon arrival in India, the team was given a series of 15 informative briefings over a period of three days by various units of the USAID, the Ministry of Agriculture, the Central Water and Power Commission, the Central Ground Water Board, the Indian Council of Agricultural Research, the World Bank and the Ford Foundation, among others.

II. Travel*

Escorted by Mr. E. D. Butler, Mr. Donald Haslem and Mr. U.S. Madan, the team visited the Chambal Drainage project of the UNDP at Kotah, Rajasthan State. This was not one of the pilot projects studied, but it represented an attempt to alleviate a severe water logging and salinity problem on relatively flat land and was helpful in understanding drainage problems in India. This project also involved ownership consolidation as a part of the land treatment.

Another trip, not closely related to the three pilot projects, was made by one member of the team, Mr. F. A. Prange, accompanied by Mr. E. D. Butler, Mr. J. S. Bali and others. This was a visit to the Damodar Valley Corporation Watershed project near Hazaribagh, Bihar. A part of the project is in West Bengal.

Most of the team's travel time, however, was spent at the three pilot projects. One week was devoted to observation and study at the Center and one week at each of the three pilot project areas. They are characterized briefly below:

III. The Soil and Water Management Central Office Team

The Soil and Water Management Central Office team (New Delhi) started in 1966 and concerned itself with development policies, programs and procedures at the central administrative level. In addition, handbooks, field guides and other technical materials ** were developed jointly by U.S. and Indian technicians.

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* See Appendix I for detailed itinerary.

** See Appendix IV.

IV. The Regional Soil and Water Management Pilot Projects

A very brief background of the three pilot projects studied is given here in order to identify, locate, date and otherwise characterize them. Several detailed reports have been prepared in the past giving complete descriptions of these projects *** and detailed repetition here seems unnecessary.

a) Bellary

The Bellary Regional Soil and Water Management Pilot Project, State of Mysore, Tungabhadra Command Area, was started in 1967 but was not officially established until October of 1968 when sanction by the Mysore State Government was given and the project became operational. This was the first of the three pilot projects to be established and it was the first of its kind in India.

The project is located on the so-called "black cotton soils," that are medium to deep dark gray clays, and the shallow loamy red soils of that area. Both types are residual, relatively infertile and have physical characteristics that make them difficult to manage. These soils lie over massive to somewhat fractured granitic bedrock, considered to be of low ground water potential, but which does not seem to have been adequately tested for tubewell development.

The project includes both irrigated and rainfed water management studies. A detailed work plan was published in April 1969, project activities began the same year and the training program was started in 1970. Considerable technical assistance has been provided outside the project area.

b) Dohrighat

The Dohrighat Regional Soil and Water Management Pilot Project, State of Uttar Pradesh, Azamgarh District was started in mid-1969 and actual field work did not get underway until 1970.

This project is located on the fine to very fine textured alluvial soils of the Gangetic Plain. These soils are relatively fertile, deep, flat and lie over a vast ground water supply that is relatively shallow and of good quality. Tubewell development, to augment surface water supplies is being rapidly expanded.

*** See Appendix III.

c) Patiala

The Patiala Regional Soil and Water Management Pilot Project, State of Punjab, Patiala District, was started in early 1969, about six months after Bellary and six months before Dohrighat. The area is in the 25" rainfall zone of the Gangetic Plain, the topography is flat to gently rolling, with slopes from 0% to 4% with frequent sand dunes showing above the flatter overall relief. Dune slopes are frequently 12% to 13%. Soils are predominantly sandy over 70% of the area; they are of moderate to low fertility but respond well to fertilizers and they lie over relatively shallow ground water of good quality. Tubewell development is progressing rapidly and electric as well as diesel powered pumps are common. This is a more progressive agricultural zone than either Bellary or Dohrighat.

V. Need for Technical Assistance

Traveling in the field, visiting irrigation projects and being briefed by Indian field technicians, one gets the impression that there are literally thousands of field men in each state but only a very few capable of carrying out the soil survey, engineering design, field staking and supply and drain ditch layout needed to allow good soil and water management practices by farmers. At this level, the need for massive outside technical assistance seems urgent, even acute. The very few acres to which good soil and water management techniques have been applied enhance this idea.

On the other hand, at the top state level or at the Ministry of Agriculture in New Delhi, being briefed by highly trained soil scientists, engineers, agronomists and administrator, one gets the definite impression that the technical expertise required to get modern soil and water management techniques applied widely in India have been well known, broadly understood, planned for, budgeted and scheduled for some time. Reading the many technical papers published by these skilled technicians and the scientifically sophisticated documents prepared by them for international conferences, strongly reinforces the idea that the needed knowledge is available and understood at high levels.

This apparent paradox is a puzzling one and at least partly explains the appeal for assistance by one group and the declaration that India does not need foreign assistance by another. When viewed analytically it may well be that both of these disparate expressions are true in one context or another.

There appears to be a wide gap between the great numbers of partially trained field technicians and the highly polished but thin veneer of very competent and knowledgeable people at the administrative level. These two groups do not seem to speak the same language, resulting in a very slow

application of knowledge, which is abundant, to field problems, which are legion. The gap between these two groups needs to be filled with practical, broad-gauge, well-trained, problem-oriented agricultural technicians, competent to apply the best soil and water techniques to farmer's fields, or train others to do so, and advise farmers on the most productive use of available water supplies. This type of field technician seems to be rare in the states visited. Perhaps foreign assistance could be useful in this critical area so that scientific techniques and knowledge can be transferred to field application promptly. Most of the nations from which technical assistance in soil and water management might be expected, have already made and corrected most of the possible mistakes in this field, a process which India need not, and can ill afford to, repeat.

It is precisely in this area that the three pilot projects evaluated herein have been working, apparently with significant success. The importance of these projects appears to lie in the fact that their basic impact is in this critical technique application area that does not seem to be intellectually stimulating for the highly skilled scientist but is beyond the competence of the average field technician.

Foreign technical assistance then, if it is to serve a useful purpose, should concern itself with the myriad factors that impinge upon the farmer's incentives to produce beyond his family's needs, but limited to those factors that are not already well developed and institutionalized in India. The application of soil and water management techniques to farmers' fields, so that the greatest production, consistent with the wise use of production resources, can be achieved is an appropriate foreign assistance endeavor. There is perhaps no other agricultural technique that can, in a reasonable time frame, add as much to India's farm production.

B. PROJECT EVALUATION - The Central Team

I. Objectives

With the initiation of the project in 1967, a team of experts in soil and water management was stationed in New Delhi to work with top level people of GOI primarily in the Ministry of Agriculture, Ministry of Irrigation and Power (GWPC), and the Indian Council of Agricultural Research, to develop policies and programs for an integrated approach to a soil and water management program for India. At that time India did not have a coordinated soil and water program. There were few technical people, there were no technical handbooks for soil and water, there were no pilot projects and but little research.

Following the general guidelines elucidated by Don Williams in his 1966 report, the team set about to assist India to build a strong organization patterned after the U.S. Soil Conservztion Service to focus on the soil and water problems of India. Technical people assigned to the central team included specialists in Irrigation and Drainage, Hydrology, Sedimentation, Soils, Engineering, Ground water, Tubewells, Economics and Resource Inventory and Evaluation. Each of these specialists worked with counterparts in the GOI and began to jointly formulate policies, instigate pilot projects, develop technical guides and handbooks, organize and promote research and exert considerable pressure towards the wise utilization of the soil and water resource for agricultural production in India.

II. Accomplishments

The total American effort at the Center level is in excess of 27 professional man-years and in the five-year period since 1967 the central team has, with their counterparts:

a) organized, staffed and implemented three pilot projects to introduce an integrated approach to soil and water management. These pilot projects are located at Bellary, Dohrighat and Patiala. They were staffed with American specialists consisting of a Water Management specialist, located at the state capital, an Agricultural Engineer (Irrigation), ar Agronomist and a Soil Scientist with Indian counterparts. These pilot projects will be discussed in more detail in other sections of the report.

b) Developed and published significant works as follows:*

1. Handbook of Irrigation Water Management
2. A Guide for Estimating Irrigation Water Requirements
3. Handbook of Hydrology
4. Soil Survey Manual
5. Handbook of Sedimentation

c) Assisted in generating a number of technical and professional papers in the soil and water management area.

d) Assisted in launching a research program with greater emphasis on soil and water.

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* See Appendix IV for complete listing.

e) Developed policies and procedures for implementing soil and water management programs both at the Center and state level.

f) Assisted in drafting needed legislation for Central and State Governments.

g) Provided consulting advice for specific Indian projects or conditions.

h) Arranged for outside consulting assistance to focus on specific problems.

There is no doubt that there has been a considerable change in the thinking regarding the importance of irrigation water management in India in the past decade and especially in the past few years.

A very recent publication by the Ministry of Irrigation and Power, "Report of the Irrigation Commission 1972" details this new look at irrigation. The Central team was undoubtedly an impelling force in this change. Additional recent papers by Vohra (See Appendix III for listing) indicate the change in thinking and issues involved. Although the changes necessary have not yet reached the action phase with regard to the traditional operation of the irrigation canals in India, the private tubewell development program indicates that the changes are essential to deliver water in the right amount and at the right time for the high-yielding varieties.

The importance of water management for agriculture in India is now known but the full impact will not be achieved for some time because of the work required to realize the full potential. The soil and water management project and the Central Team have been instrumental in bringing the potential to light and could continue to be of assistance to India in formulating policies and other activities required. The evaluation team agrees that an effective program has been carried forward.

C. PROJECT EVALUATION - The Pilot Projects

I. Goals and Objectives

Objectives of the pilot projects have been set forth in the project reports as shown in Appendix II. The projects appear to be technically sound in their conception with an integrated approach to the problems of on-farm water management envisioned in the design. The integrated approach idea implies the involvements of several branches of technology including engineering, agronomy, soils, and economics to focus on the problems as a team. The pilot projects also envisioned the management of water so as

to provide the right amount at the right time for optimum crop production. It was recognized that the projects were concerned primarily with adapting known technology including that from other countries to conditions in India and furthermore to provide a location where new ideas and information could be tested.

II. Accomplishments

The project activities actually started in the field in Bellary (Mysore) in 1969 followed by Patiala (Punjab) and Dohrighat (Uttar Pradesh) in 1970. Many difficulties were encountered by the field staff involving the assignment of counterparts, organizing the program and securing farms for field-scale trials. However, in this short time the projects have:

1. Introduced an integrated approach to on-farm water management.

2. Confirmed the hypothesis that increased yields would result.

3. Convinced some cultivators of the value of proper land preparation and water management.

4. Trained a number of technicians in the various technical components of water management and associated practices.

5. Impressed some officials with the importance of water management.

6. Published project work plans.

7. Developed technical guides and standard specifications.

8. Introduced modern land grading techniques.

9. Produced standard detailed soil surveys and evaluated irrigation systems.

10. Completed construction on a number of field trials on farms.

However, at this time it would be inappropriate to label the projects as completed and highly successful. To a degree, some progress has been made on all objectives. Some progress has been made with State and Center personnel in obtaining a concerted approach to the water management problems, but a unified commitment and viable program do not exist.

III. Interpretation and Comments

Plans of action and technical guides have been developed largely by modification of the technical guides which evolved with the growth of the SCS program in the USA. It is doubtful, however, that these have been sufficiently tested and adapted to the conditions in India to have been learned and believed in by the technicians who must apply them. Land grading and modern irrigation layouts with the accompanying recommended soil and water practices and management techniques have been applied to only a small percentage of land anticipated to receive this improvement. Where the applications have been made, the impact on yields is fantastic but it has not yet generated an enthusiastic clamor on the part of adjacent landowners for an extension of the program to their lands. Little progress has been made in generating community action to construct, operate or maintain joint irrigation and drainage works. Water projects, especially irrigation, usually require group action and cooperation. It is essential that cultivators share the irrigation facilities to their mutual advantage. They should also have a voice in policies concerning method and timing of delivery because such policies often dictate how and when the water must be used. Policies and procedures of water delivery often place constraints on the water use and thus reduce its value. It is suspected that such disincentives may be operating in India for it is reported that farmers will pay double for water from a private tubewell as opposed to taking water from government canals or public tubewells where they have less control over timing and reliability.

The testing and evaluation of applied practices lacks the time required. Data are available for only one year from one of the projects but preliminary economic analysis indicates very favorable benefit-cost ratios. In this connection it should be mentioned that the land development costs almost always are higher during the trial periods than they are after the procedures are streamlined and become more routine. If this proves to be the case, the practices will undoubtedly prove to be a good investment.

Some training has been provided to a fairly sizeable group of technicians (161 at Bellary, 61 at Dohrighat and 51 at Patiala). The degree of dedication and ability of these trained technicians to carry the project forward is still unknown.

In discussing the pilot project program with the Indian technicians at all three projects, one is left with the idea that considerable momentum would be lost if the foreign technical assistance program were to be phased out at this time. Some estimate that more than 50 percent of the present momentum for on-farm water management which is admittedly small would be lost with the phasing out of the technical assistance supplied by other countries. It was even indicated that the program might cease to exist in some states.

At this stage the team agrees that the projects are just reaching the point where some significant progress can take place and reliable data collected for the evaluation of the practices and work envisioned when the projects were conceived. Economic evaluations, the use and testing of the technical guides, and the observations of the work of technicians to measure their technical competence are yet to come. The team also recognizes that before a concerted effort can be made in solving the on-farm water management problems in India there needs to be a firm commitment on the part of both Central and State governments to the program. This suggests continuance of the pilot projects and, in addition, the initiation of a massive program of technical support and financial assistance for the needed physical works. The inability of the pilot projects to generate more enthusiasm on the part of government officials and adjacent landowners is not fully understood. The team recommends that some attempts be made to identify the constraints and disincentives that might be factors in preventing acceptance and spread of the modern technology. It would be unfortunate if political difficulties were allowed to override technical considerations and social and economic needs.

D. EXPANSION OF PILOT PROJECTS EXPERIENCE TO LARGE AREAS

I. Major Problems

Traditional irrigation in India seems to be based upon an extensive (famine relief) system in which the area under command is comparatively vast with regard to the available water supply. This was recognized by Mr. Don Williams in his report in 1966 (see reference 4, Appendix III) and reiterated in his later reports of 1970. The traditional irrigation system was very well engineered from the standpoint of major canals, dams, control structures, gates and other engineering devices. Lacking was the adjunct of on-farm irrigation systems and the excellent engineering of the major works was not extended to the requirements of the fields to be served. Traditionally the canals have also been operated as efficient hydraulic systems with little regard for the crops water requirements and timing of water delivery, now so important with the cultivation of high-yielding varieties. Recently many reports have been issued indicating the need for water at the right time and in the right amount. An evolution is taking place in thinking concerning the administration of water for agriculture (see Vohra and others, etc.). A technical Advisory Committee has been established and is presently operating to assure that the views of the Ministry of Agriculture are taken into account before any new irrigation schemes are sanctioned. This is a significant step towards managing water for agriculture.

The existing structure of water resource administration coupled with the small farm units and fragmented holdings of the farmers greatly complicates the problem of agricultural water management. The requirements of the high-yielding varieties demand timely irrigation, proper amount of water and uniform distribution of water. These demands in turn require land preparation and good irrigation design. This is the water management component of the package of practices that is necessary to take full advantage of the high-yielding varieties.

II. Essential Services Needed

From the standpoint of on-farm water management it appears that there are technical services which must be provided to the farmer. These involve applying sophisticated techniques that the cultivator is not qualified to perform and should not be expected to perform without assistance. Such services can only be provided by a dedicated field technician who is willing to spend most of his time in the field. They include:

1. Land grading assistance including survey and design of the proper grade for the specific site condition, staking of the field for land grading operations and inspection of the finished land grading job.

2. Engineering design and farm layout for both irrigation and drainage at the farm level. This includes farm ditches and control structures as well as drainage facilities.

3. Water management assistance. Farmers should be advised regarding the right time of water application as well as the proper amount of water to be used. It is anticipated that this service could best be performed by an irrigation advisor servicing a group of farmers by giving them direct assistance, or by conducting workshops and training sessions to provide them with the needed knowledge and experience to make their own determination. The irrigation advisor would also help in identifying other water management problems of the areas such as high water table, salinity or the accumulation of excess surface water which would indicate the need for surface or sub-surface drainage.

4. An additional service that the farmers require is agronomic assistance concerning the variety of seeds which should be planted and the fertilizers required. Additional information such as the date and density of planting, cultivation procedures for weed and pest control and other associated activities is also required. As the program progresses, the farmer will also need assistance in marketing, credit and farm management techniques.

III. Within-Package Priorities

The pilot projects envisioned providing all of these services in an integrated way. The team agrees with the integrated approach but suggests that priorities might be assigned within the integrated package. A significant program could then be undertaken on one of high priority items in order to make a sizeable impact. The priorities agreed on by the team would be as follows:

a. Land Preparation - This includes leveling and grading and preparation of the farm soil to enhance its efficiency to receive and store water. This is a necessary condition to the control and management of water on the farm. Good design reduces and simplifies the decisions that must be made by the irrigator and partially directs him toward making the right decisions.

b. On-Farm Water Application and Removal Systems - This involves the design and construction of devices and structures for the application of water to the land such as field ditches, pipelines, turnouts, checks, furrows, borders, sprinkler systems, etc. Like land preparation it is also a necessary condition to modern on-farm water management.

c. Modernization and Improvement of Farm Delivery System to ensure water availability at the farm on a timely basis. Overnight storage tanks, tubewells and other additions to the water supply network may be required.

d. Water Management Assistance to provide the cultivator with the necessary advice and information regarding (1) when to irrigate; (2) how much water to apply; (3) water application practices as related to crop requirements and responses; (4) leaching requirements; and (5) water table control.

e. Agronomic Assistance regarding best crop varieties, planting dates, fertilizers, pesticides and management techniques.

f. Credit to provide capital for the necessary construction, seeds, fertilizers, and other inputs.

g. Organizational Advice to assist the cultivators in organizing cooperatives for dealing with water delivery policies, marketing, produce, storage facilities and other items requiring group action.

Other items could be added to the list and the priorities might be altered for given situations. However, improvement of the physical

capability of the land for modern water management is a necessary first step and will remain at the highest level of priority. It is certain that essentially all of the area ultimately practicing intensive irrigation will require land grading or smoothing and a modern water application and removal system.

In 1969 there were 27.2 million acres under canal irrigation, about the same amount under tubewell irrigation, and 14.8 million acres irrigated from tanks, diversions, or rivers, etc. This totaled about 70 million acres. By 1972 this figure probably reached 80 to 85 million acres. A 30-year program to increase the country's irrigated area to 200 million acres, or about 50 percent of the total cropped area in India, has been recommended by the Irrigation Commission which was set up in April 1969.

A program to insure good on-farm water management by providing land grading and a modern water application and removal system for each farm would require a rather massive input of technology and capital but it would be the first step necessary toward efficient utilization of the water supplies already developed and those yet to be exploited. Land areas where adequate water supplies are available or can be developed for intensive irrigation need to be identified and government programs coordinated to insure that any land preparation effort is planned and implemented on these water-sufficient areas. Priorities and schedules for accomplishment should be established to insure that land to be leveled and developed for water management will have adequate water available for planned crop production.

IV.Manpower Estimates

Manpower requirements for irrigation land leveling in the United States, based on a report by the U.S. Soil Conservation Service for the year 1967, show that for the 449,216 acres leveled that year the average SCS time amounted to 0.953 man hrs/acre and the total technical time amounted to 2.09 man hrs/acre. Twenty-five of the fifty states had land grading programs that year and the requirements in technical man-hrs/acre ranged from a low of 1.0 man hrs/acre to a high of 5.7 man hrs per acre, the high requirement being in a state having a minimal program of only 14 acres in the year. Where sizeable programs were in operation, the manpower requirements for technical support were well below the average values given above. These figures are for surveys, designs, staking the work and checking the final completed land grading job but do not include the machine time for the earth moving costs.

It is noted that conditions in India are very different from the U.S. The farms are smaller and they are irregular both as to size and shape. It is estimated therefore that a four-man team could provide technical survey and design services for an average of 2.5 acres per day (12.8 total man hrs/acre). This is more than double the maximum reported for

the irrigation land leveling in the U.S. and more than six times the average U.S. values of 2.09 man hrs/acre. On this basis it is conservatively estimated that a four-man team working eight hours per day 200 days per year would complete the designs for 500 acres per year.

In making these estimates it is assumed: (a) that the teams are fully trained, properly equipped and provided with adequate transportation, (b) that eight hours of productive work are produced each day, (c) that the areas of work are sufficiently contiguous to allow efficient operation and (d) that adequate technical support staff are provided at all levels.

The duties of the team might vary slightly but might be briefly outlined as follows:

1. Engineer -- act as chief of party and design irrigation system, grading, length of run, method of application, etc.

2. Instrument man -- for surveys, staking of land grading and construction work and check final construction.

3. Rodman -- assist instrument man with all duties.

4. Recorder -- assist in recording of surveys, computations and plans.

Using the above estimates and background information, Table I was constructed to indicate what would be required in India to produce the irrigation land leveling requirement for a target area of an estimated 35 million acres in the next ten years. It was realized that some time would be required to train the necessary technical teams and a top strength of 10,000 teams was assumed.* If only 5,000 teams could be foreseen, then the rate of accomplishment would simply be cut in half. This proposed rate, however, is very slow and greater efficiency could probably be achieved by the time 5,000 teams have been trained and equipped.

* See Table I.

Table I

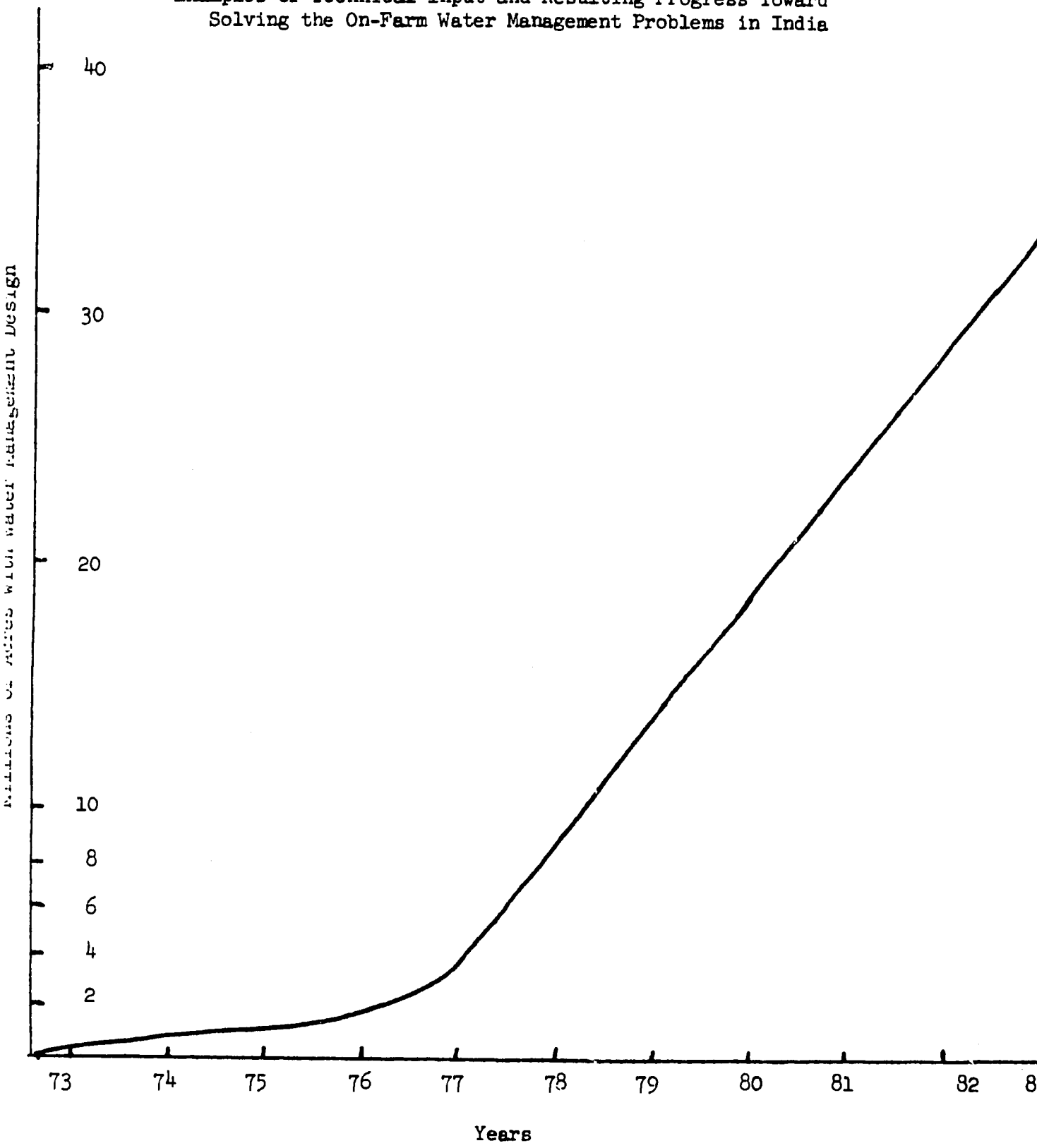
Example of Technical Requirements for On-Farm Water Management Designs

Year	No. of Teams	Designs completed each year acres (000)	Accumulated acreage end of year (000)
1973	250	125	125
1974	750	375	500
1975	2,000	1,000	1,500
1976	5,000	2,500	4,000
1977	10,000	5,000	9,000
1978	10,000	5,000	14,000
1979	10,000	5,000	19,000
1980	10,000	5,000	24,000
1981	10,000	5,000	29,000
1982	10,000	5,000	34,000

Figure 1 shows Table I graphically and indicates what might be accomplished in the 10-year beginning January 1, 1973.

Figure 1

Examples of Technical Input and Resulting Progress Toward Solving the On-Farm Water Management Problems in India



As indicated, the technical service needed would require a rather sizeable input of technical manpower. The actual construction would require a considerable capital input but because it is a physical input it could be highly labor intensive. Whether the land grading and appurtenant construction is done by head basket, bullock or machine, it is the necessary first step in a modern intensive irrigation program.

Once the land has been graded and the necessary water application and removal systems constructed, the balance of the integrated practices will naturally follow. However, because much of the remaining practices do not require physical construction, their application will be more subtle but of equal importance. The main advantage in beginning with the physical program is to have something visible which is assured of success resulting in the generation of confidence in the program making the non-physical, more subtle programs, somewhat easier to launch.

Some Observations on other Soil and Water Priorities

The scope of work assigned to the Evaluation Team was restricted to evaluation of the results of the soil and water project as currently conceived and making of recommendations which would lead to large scale adoption of proven practices and techniques. Consequently, the team did not spend much time looking at other aspects. However, from rather limited observation, reading and discussions, it is suggested that the GOI and USAID examine possibilities for:

a) Broader approaches to soil and water management which would include also ground water and rainfed agriculture. This should include practices for water conservation and land management to utilize soil and water effectively both in the short and long run.

b) Comprehensive watershed treatment to reduce erosion and silting of reservoirs.

APPENDIX I

Itinerary for Soil and Water Management
Project Evaluation Team

March 6 Monday	0830 - 1200	Check-in formalities.
	1300 - 1430	Met with Butler and staff on schedule arrangements, and objectives of the evaluation team in Conference Room
	1500 - 1700	Met with S. K. Jain and Naegamvala, CW&PC and visit Engineering Museum.
March 7 Tuesday	0830 - 1000	Met with Central Unit for Sedimentation and Hydrology - Mildner and Vandersypen.
	1015 - 1200	Met with B. B. Vohra, Dr. Rege, and other staff members of the Water Management Division.
	1400 - 1500	Met with Y. P. Bali and O. F. Bailey on Conservation Needs work carried out during Roberts' tour.
	1530 - 1700	Met with J. S. Bali, Mildner and Vandersypen.
March 8 Wednesday	0830 - 1000	Met with members of the Soil and Water staff individually - Haslem, Bailey, Caldwell and Madan - Also met other members of the AID Mission and Agriculture Division.
	1030 - 1200	ICAR - Dr. Swaminathan and Dr. Kanwar.
	1400 - 1430	Met with Oechsli - Gulick.
	1430 - 1515	Met with Program Division Representatives in Conference Room.
	1530 - 1630	Met with J. K. Jain and L. N. Laddha on Groundwater and Minor Irrigation
	1630 - 1730	Met R. N. Gupta of Foreign Assistance - Krishi Bhavan.
March 9 Thursday	0900 - 0945	World Bank - Peter Naylor.
	1000 - 1200	Met with Ford Foundation Soil and Water Use Management - Tyler Quackenbush.
	1330 - 1730	Central Ground Water Board, Faridabad - Dr. Raghava Rao.

March 9	2210	Lv: New Delhi by rail (Dehradun Express)
March 10	0745	Ar: Kotah (Visit UNDP Drainage Project - Mr. Siegfried Kruse Mr. Dennis Simms)
March 11 Saturday	2004 0555	Lv: Kotah by rail (Dehradun Express) Ar: New Delhi Met B. B. Vohra.
March 13 Monday	0620 0940	Lv: New Delhi IC-403 Ar: Bangalore
	1300 1800	Lv: Bangalore Gov't. auto Ar: Bellary
March 14	0800	Kelur Village - Visit land improvement work done by regular land development staff. Kurugodu Village - Discussions with Shri Rajashekar Gowda, leading cultivator and visit to actual land development work near Badaratti. Eminganur Village - Observe 268-acre dry land demonstration, inspection of irrigated crops on recently leveled land, and visit to a reorganized paddy field.
	1530 1730	Met with Deputy Commissioner, S. Viswanathan and Executive Engineer, H.L.C.
March 15 Wednesday	0800 1300	Siddammanakalli Village - Visited G. Hanumanthappa irrigated farm (22 acres) and 4-R watercourse group demonstration on return. Yelbenchi Village - Inspected 15-acre land development demonstration on R. Ramachandradas farm. Pattanasavagu Village - Observed land development work done by the regular development sector and also low cost per acre project demonstration.
	1400 1730	Travel to Siruguppa Research Station to discuss work being carried out on irrigated Black Cotton Soils.
March 16 Thursday	0830 1100	Met with USAID and project staff including: N. P. Jahagirdar, Dy. Director of Agriculture (Project Officer), M.K. Kulkarni, Agricultural Development Officer (Agronomy); T. Seshagiri Rao, Agricultural Development Officer (Engineering); R.V. Kulkarni, Agricultural Development Officer (Soils).
March 16 Thursday	1300 1800	Lv: Bellary Gov't. Auto. Ar. Bangalore
March 17 Friday	0830 0930	Met with Univ. of Tenn. group; G. Welling, W.Ward and T. Longford.

	0930 1030	Met with acting Joint Director of Agriculture (Soil Conservation).
March (contd..)	1100 1200	Met with Director of Agriculture, Dr. H.L. Kulkarni.
	1500 1600	Met with G.V.K. Rao, Development Commissioner for Mysore State.
	1705 2050	Lv. Bangalore IC-404 Ar. New Delhi
March 20 Monday	0600 0755	Lv: New Delhi (C-409 Ar: Varanasi
	0900 1200	Lv: Varanasi Gov't. auto Ar: Dohrighat
March 21 Tuesday	0800 1000	Discussion about project with members of team and project personnel.
	1000 1300	Field trip to Gontha tank, saline project, Amila State T.W. Ibrahimabad.
	1430	Field trip to Outlet No. 2 and 4 of main canal, Surajpur Minor.
March 22 Wednesday	0800 1230	Discussion with project personnel
	1400 1545	Discussion with Executive Engineer (Tubewell); Executive Engineer (Canal) and Executive Engineer (Minor Irrigation).
	1545 1600	General discussion with project staff.
	1600	Discussion with USAID experts.
March 23 Thursday	0700 1400	Lv: Dohrighat Gov't. auto Ar: Lucknow

Dohrighat

Project

Dr. R. D. Singh, Dy. Director, Soil Conservation (Project Officer)

Mr. R. Shahi, Project Engineering Specialist
Mr. B. Tripati, Project Soils Scientist

Irrigation

Mr. H.N. Jalote, Ex. Engineer, Minor Irrigation, Gorakhpur.

Mr. S. C. Srivastava, Ex. Engineer,
Tubewell, Balia

Lucknow

Agriculture

Mr. R.D. Sanwal - Agr. Production Commissioner, Uttar Pradesh

Mr. R.N. Azad - Spl. Secretary, Agriculture, U.P. Government.

Mr. Ram Krishan - Director of Agriculture, U.P.
Mr. Amar Singh - Additional Director of Agriculture (SC), U.P.

Irrigation

Mr. A.N. Harkauli - Chief Engineer, Irrigation, U.P.

Mr. J. P. Agarwal - Superintending Engineer, Minor Irrigation, U.P.

Mr. D.M. Kharbanda - Executive Engineer and Personal Assistant to Chief Engineer, Irrigation.

March 24 Friday	1430 1520	Lv. Lucknow IC-410 Ar. New Delhi
March 27 Monday	0630 1205	Lv: New Delhi IC-411 Ar: Ranchi Lv: Ranchi by car Ar. Hazaribagh
March 28-29		Damodar Valley Corporation (Watershed Project) Met with the following: Mr. S. Muhammad Dr. S.P.S. Teotia Mr. J.S. Bali Mr. L.K. Pandey Mr. B.N. Tewaki Mr. G.N. Pandey Mr. R.K. Mukherjee and Dr. G.B. Pant
March 30 Thursday	1045 1625	Lv: Ranchi IC-412 Ar: New Delhi

April 3	0800	Lv: New Delhi via Govt. auto
Monday	1300	Ar: Chandigarh

Met with:

Mrs. S.S. Grewal, Development Commissioner, Punjab.
Mr. G.S. Dhillon, Chief Conservator of Soils, Dept. of Soil Cons. and Engg.
Mr. S.S. Sahi, C.E., Drainage, Irrigation Department
Mr. M.M. Anand, C.E., Canals, Irrigation Department

April 4	a.m.	Conference in Office
Tuesday	p.m.	Met with Mr. J.S. Gill, Superintending Engineer, Construction Circle, U.T. Toured Sukhna Lake Watershed.

April 5 Wednesday — Lv. Chandigarh - Visit Soil Conservation work enroute to Ludhiana - Mr. Karnail Singh

Ludhiana District Soil Survey and Resource Inventory - Mr. H.S. Kanwal

Travel to Patiala

April 6 — Visit with J.M. Sharma, Project Officer
Tour part of the Project.

April 7 — Complete Project Evaluation.
Friday — Ar: Delhi

April 10-14 — Team completed report.

April 15 — Dr. Newberg accompanied by Dr. Cox had final meeting with Mr. B.B. Vohra to discuss the draft report.

APPENDIX II

Project Objectives

Uttar Pradesh Regional Pilot Project

This pilot project has been established to:

1. Provide an opportunity for bringing together the various disciplines to identify the social and physical problems and needs relating to soil and water management in a soil and water resource area and to develop a plan of action and a technical guide for land treatment, and a water and crop management program designed to meet the problems and needs.

2. Test, evaluate and demonstrate the management techniques to make most efficient use of soil and water resources.

Mysore Regional Pilot Project for Soil and Water Management

1. Provide an opportunity for bringing together the various disciplines to identify the soil and physical problems and needs relating to soil and water management in a soil and water resource area; and to develop a plan of action and a technical guide for land treatment, and a water and crop management program designed to meet the problems and needs.

2. Develop and provide training for an organization and groups of Government of India and Mysore State professional agricultural workers at different levels who can effectively give technical and other assistance to cultivators in planning and applying a soil and water management program designed to give optimum economic benefits through proper water use and consistent with conservation and maintenance of soil resources.

3. Test, evaluate and demonstrate the management techniques to make most efficient use of soil and water resources.

Punjab Regional Pilot Project for Soil and Water Management

1. Provide an opportunity for bringing together the various disciplines from the different fields of agricultural technology to:

(a) Identify the soil and physical problems and needs relating to soil and water management.

(b) Develop a plan of action and technical guides for proper water and land use treatments.

2. Test, evaluate and demonstrate the management techniques to make most efficient use of soil and water resources.

3. Develop and provide training to individuals and groups of technicians from the States, Central Government and others who will work in the field of conservation and promote the wise use of soil, water and related resources.

4. To educate and develop the concept of conservation farm planning amongst the cultivators.

APPENDIX III

List of Reports, Work Plans and Documents Reviewed

1. Regional Pilot Project Soil and Water Management, Dohrighat, Azamgarh, U.P. - Work Plan, June 1971.

2. Regional Pilot Project for Soil and Water Management, Bellary, Mysore State - Project Work Plan, April 1969.

3. Regional Pilot Project for Soil and Water Management, Patiala, Punjab State - Project Work Plan.

4. Agricultural Water Management in India - U.S. Department of Agriculture, April 1966.

5. Water Management in the Seventies - Don Williams, June 1970.

6. Water Use and Development in India in the 1970's
   D.A. Williams, August 1, 1970
   The Ford Foundation.

7. Ground Water Comes of Age - Some Policy Implications
   B.B. Vohra, Chairman, Central Ground Water Board.

8. Creation of Adequate Institutional and Organizational Support for Ground Water Development.

9. Current Trends and Prospects in Irrigation Development in India
   B.B. Vohra.

10. Need of and Plan for Research on Water and Soil Management
    Chester E. Evans, Parry R. Stont, Stephen J. Mech, R.C. Hoon, S.D. Nijhawan and C.S. Sridharan.

APPENDIX IV

List of Handbooks and Guides Prepared by
Center and Project Personnel

1. Land and Water Resources in India, 1964.

2. Need of and Plan for Research on Water Use and Soil Management toward Meeting India's Food Shortages, 1967-68.

3. Water Resources Investigation Program for Upper Gangetic Plain—India, 1967.

4. An Organizational Plan for a Comprehensive Study of the Water Resources of the Narmada River Basin, 1969.

5. Joint Indian-American Team Repoet, Efficient Water Use and Farm Management Study, 1970.

6. Report to the Government of India on Design Criteria, Construction Guide and Material Standards for Irrigation Pipelines, 1970.

7. A Project Report on the Location of Information Sources Regarding Water Resources in India. Published by Mansinghal Associates, 1968.

8. Soil Survey Manual (Revised), 1970.

9. A Guide for Estimating Irrigation Water Requirements, 1971.

10. Handbook on Water Management (Irrigation), 1971. Details of publications included in Handbook, which were published originally separately.

    Part I Soil Survey and Land Classification
    Part II Soil-Water Plant Relationship
    Part III Scheduling Irrigation to Meet Crop Needs
    Part IV Irrigation Methods
    Part V Irrigation of Principal Crops
    Part VI The On-Farm Irrigation System
    Part VII Land Leveling

11. Rotary Drilling Handbook on Accident Prevention and Safe Operating Practices, 1970-71.

12. Project Work Plan, Bellary Regional Pilot Project, 1969.

13. Project Work Plan, Patiala Regional Pilot Project, 1970.

14. Project Work Plan, Dohrighat Regional Pilot Project, 1971.

15. Technical Guide, Pilot Project for Soil and Water Management (including the Irrigation Guide), Mysore, 1971.

16. Directory for Irrigation Equipment and Related Services, 1970.

17. A Discussion on Design, Construction and Use of Well Screens, 1970.

18. Current Practices Relative to the Design and Placement of Artificial Gravel Packs for Tubewells, 1970-71.

19. Submersible Motor Pumps, 1970-71.

20. Air Injection Equipment for Reverse Circulation Drilling, 1971.

21. Developing and Completing Water Wells, 1971.

22. Water Well Specifications.

23. Development and Demonstration of Recommended Methodology for Delineation and Codification of a Watershed System of India, 1970.

24. Measurement of Irrigation Water, 1971.

25. Analysis of Chauhat Pump Drainage Scheme, Patiala, Regional Pilot Project, 1971.

26. Reconnaissance Soil Survey Report, Patiala Pilot Project, 1971.

27. Small Catchment Hydrology for India, 1970.

28. Handbook of Hydrology, 1972.

29. Handbook of Sedimentation, 1972.

30. Cylinder Infiltrometer Method for Determination of Intake Characteristics of Soils, July 1969.

31. Lining of Small Irrigation Channels, December 1970.

32. Preparing Irrigation Guides, September 1971.

33. Proceedings of Soil Survey Workshops on Classification, Correlation and Interpretations, 1972.

34. Manual and Guide for Rapid Assessment of Soil and Land Resources, 1972.

35. A Justification for Soil and Land Resource Inventories
Resource Inventory Center
Ministry of Food and Agriculture.

36. Soil and Land Resource Inventories for Broad Areas Agriculture Planning

37. Use of Land Resource Inventory for Dryland Areas.
