Staff Appraisal Report

India

National Water Management Project

Supplementary Data Volume I

Annexes 8-14

(Annexes 5, 6 and 7 will be issued separately).

February 13, 1987

South Asia Projects Department
Irrigation II Division
CURRENCY EQUIVALENTS

US$1.00 = Rupees (Rs) 13.0

WEIGHTS AND MEASURES (METRIC SYSTEM) 1/

1 meter (m) = 3.28 feet (ft)
1 kilometer (km) = 0.62 miles (mi)
1 hectare (ha) = 2.47 acres (ac)
1 million cubic meters (Mm³) = 804 acre-feet (ac-ft)
1 cubic foot per second (cfs or cusec) = 0.0283 cubic meters per second (m³/s)
1 kilogram (kg) = 2.2 pounds (lb)
1 metric ton (t) = 2,205 pounds (lb)
1 thousand million cubic feet (TMC) = 28.317 million cubic meters (Mm³)

FISCAL YEAR

GOI, GOAP, April 1 - March 31
GOM, GOK,
GOTN

1/ Wherever source material contains non-metric units, they have been converted using the above equivalents.
FREQUENTLY USED ABBREVIATIONS FOR OFFICERS

ADA - Assistant Director of Agriculture
AE - Assistant Engineer
CE - Chief Engineer
CI - Canal Inspector
DDA - Deputy Director of Agriculture
DEE - Deputy Executive Engineer
EE - Executive Engineer
JDA - Joint Director of Agriculture
LDC - Lower Division Clerk
SE - Superintending Engineer
VC - Vice Chancellor
VEW - Village Extension Worker

PRINCIPAL ABBREVIATIONS AND ACRONYMS

AD - Department of Agriculture
AED - Agricultural Engineering Department (Tamil Nadu)
AP - Andhra Pradesh
APAU - Andhra Pradesh Agricultural University
APM - Adjustable Proportionate Module
CAD - Command Area Development
CADA - Command Area Development Authority
CADD - Irrigation Utilization and Command Area Development Department (see IU and CADD)
CCA - Cultivable Commanded Area
CCF - Construction Conversion Factor
CWC - Central Water Commission
DC - Distributary Committee
DIC - District Irrigation Committee (Tamil Nadu and Andhra Pradesh)
FAO - Food and Agriculture Organization
GCA - Gross Commanded Area
GNP - Gross National Project
GOAP - Government of Andhra Pradesh
GOI - Government of India
GOK - Government of Karnataka
GOM - Government of Maharashtra
GOTN - Government of Tamil Nadu
IBRD - International Bank for Reconstruction and Development
ICAR - Indian Council of Agricultural Research
ICB - International Competitive Bidding
ID - Irrigation Department or Irrigated Dry
IDA - International Development Association
IDB - Irrigation Development Board (AP)
IMTI - Irrigation Management & Training Institute (Tamil Nadu)
IU and CADD - Irrigation Utilization and Command Area Development Department (see CADD)
IW - Irrigated Wet
LB - Left Bank
LCB - Local Competitive Bidding
LLC - Low Level Canal
M&E - Monitoring and Evaluation
MC - Minor Committee
MITP - Maharashtra Induction Training Program
MWR - Ministry of Water Resources
MSL - Mean Sea Level
NA - Not Applicable
NABARD - National Bank for Agriculture and Rural Development
NARP - National Agricultural Research Project
NSP - Nagarjunasagar Scheme
NWMP - National Water Management Project
OC - Outlet Committee
O&M - Operation and Maintenance
PAP - Project Affected Persons
PPC - Project Preparation Cell
PPF - Project Preparation Fund
PPM - Project Preparation and Monitoring Wing (of ID)
PPMC - Project Preparation and Monitoring Cell (Andhra Pradesh)
PFD - Public Works Department
R&B - Roads and Bridges
RB - Right Bank
RD - Revenue Department
RDS - Rajolibanda Diversion Scheme
RWS - Rotational Water Supply
SCF - Standard Conversion Factor
SDV - Supplementary Data Volume
SRBC - Srisailam Right Branch Canal
SRS - Srisailam Scheme
SS - Sathanur Scheme
TMC - Thousand Million Cubic Feet
TN - State of Tamil Nadu
T&V - Training and Visit (system of agricultural extension)
VEW - Village Extension Worker
VVS - Vanivilas Sagar Scheme, Karnataka
WALAMTARI - Water and Land Management Training and Research Institute (Andhra Pradesh)
WALMI - Water and Land Management Institute (Karnataka)
WMC - Water Management Cell

GLOSSARY

Anicut - Barrage
Ayacut - Command Area served by a barrage
Chak - Area served by watercourse, typically 15 ha to 40 ha
District - The lowest administrative unit where the State Government is directly involved
Hot Season - March to May
Kharif - Wet Season (June to September)
Laskar - Irrigation Department Field Worker
Neergati - Man who irrigates on behalf of farmers
Participating States - Andhra Pradesh, Karnataka, and Tamil Nadu
Rabi - Dry season (October to February)
Shejpali - Irrigation water supply system used in Gujarat and Maharashtra
Taluka - A sub-division of a district
Warabundi - NW India rotational water system

PROJECT TERMINOLOGY

Project - The entire National Water Management Project
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INDIA

NATIONAL WATER MANAGEMENT PROJECT

Institutional Strengthening

1. The Operation and Maintenance (O&M) of irrigation facilities is a specialized activity, requiring specific skills, experience and training. Ideally, operations should be planned at the State level on a basinwide basis. Water allocations among schemes within a basin would be defined and communicated to scheme-level authorities. At the scheme level, an officially constituted Board or Committee, representing concerned Government agencies (Revenue, Irrigation, Agriculture, CAD) and the users, would have management responsibility, and would agree to the annual and seasonal operational plan. A single organization would have responsibility for water delivery in accordance with the operational plan from the diversion point to the Government outlet, as well as supervisory responsibility, as necessary, for organizing distribution among the farmers below the outlet. The organization of maintenance activities should directly parallel that of operation, with State-level allocation of funds and programming of work among schemes, and scheme level staff responsible for all works within the project area and for supervising farmer maintenance activities below (and possibly above) the Government outlet.

2. Under the proposed NWMP, rationalization and specialization of the O&M organization would be initiated at the State level, and fully implemented at the scheme level. The detailed arrangements for implementing the NWMP, and the support to be provided, would reflect individual State circumstances (see below), but in each participating State:

(a) The Project Preparation Cell (PPC) would prepare NWMP sub-project proposals in close coordination with the proposed O&M cells, and would manage NWMP implementation;

(b) An O&M cell will be established/strengthened to give direction to the State's O&M activities, and support and monitor scheme O&M programs;

(c) A scheme level committee with both official and farmer representation will have decision-making responsibility for the scheme, will meet before each irrigation season to approve the operational plan and define the rules for its implementation, and after each season to evaluate the experience gained;

(d) A single O&M agency will be assigned responsibility for water delivery within each scheme in accordance with the decisions of the committee subject to the overall policy of the State Government;
(e) Agricultural supporting services will be programmed in support of, and to complement, the irrigation management plan adopted; and

(f) Systematic linkages will be developed between the O&M agency, other Government agencies and the farmers.

3. This annex describes the State and scheme level arrangements for O&M in each of the participating States, how these are to be supported under the NWMP and how the NWMP itself will be implemented. Annexes 9, 10, 11 and 12 describe the programming of agricultural supporting services (Annex 9 - Agricultural Research, Annex 10 - Agricultural Extension), linkages between agencies (Annex 11) and farmer participation (Annex 12). Annex 13 describes how monitoring and evaluation will be undertaken within this institutional framework and Annex 14 describes supporting training activities.

The PPCs and O&M Cells

4. An important component of the project will be to strengthen the capacity of the State Irrigation Departments to:

   (a) plan, implement and monitor scheme improvement projects such as those included under the NWMP, and

   (b) to provide ongoing O&M policy, planning and implementation support.

The former will be the responsibility of the existing Project Preparation Cells (PPCs), the latter increasingly of the newly formed O&M cells. As the O&M cells develop and become established, the balance of responsibilities between the PPCs and O&M Cells may change.

5. The PPCs were in each case established with assistance from IDA through previous Project Preparation Funds (see para 3.27 of the Main Report). Their original purpose was to prepare investment projects to standards suitable for forwarding to the Bank and other international financing agencies. Based on data collected and compiled by other units, the PPC was to formulate projects in terms of water and land use, infrastructural development, operational guidelines and the financial and economic value development (e.g. as contained in the Five Year and Annual Development Plans) and with the master plan for the river basin concerned. In practice, while they formed part of the State plan, such projects have seldom been placed within a comprehensive basin plan. Water allocations between schemes may be made in accordance with an interstate agreement (e.g. for the Krishna and Godavari), or may reflect the accumulation of water rights, but river basin master planning as such has still to develop on a systematic basis, in part due to the complications of interstate issues.

1/ Notably those responsible for: (a) basic resource investigations, e.g. climate, soils, hydrology, groundwater, etc, (b) engineering surveys and investigations, (c) socio-economic and related surveys, (d) scheme operations (for existing schemes) and (e) technical services (e.g. research.
6. Given their functions, formulation of the NWMP for IDA financing was entrusted to the respective PPC in each of the participating States. Thus, while the essential focus of the NWMP is on O&M, the project was formulated by a project investment planning unit. Since they are already well-established, it is proposed that they continue to be responsible for implementation and progress monitoring of the NWMP and, in each case, divisions will be established in the PPC for this purpose. However, it is crucial that the O&M focus of the NWMP be maintained. This will be achieved both through the approach to sub-project preparation (SAR, Annex 4) and, increasingly, by involving the newly formed O&M cells closely in sub-project formulation. Ultimately, it is possible the latter will assume full responsibility for the NWMP.

7. The PPCs will continue to be responsible for preparing investment projects for foreign financing. Since there is no reason for adopting differing standards for foreign and locally-financed projects, it is expected that they will increasingly assume responsibility for all project preparation and in some cases this has already occurred. It will also be important to ensure that all projects are placed within a coherent basin plan, and consideration needs to be given to how the activities of the PPCs can be integrated with the incipient efforts at basin planning being initiated in the States. Similarly, it must be placed within the context of statewide planning (normally undertaken in the office of the Secretary or Engineer-in-Chief) which establishes priorities between projects and allocates investment resources. Finally, consideration needs to be given to how the three levels of planning (at the state, basin and project levels) are best organized in relation to basic resource investigations, its data collection activity. Separation of planning and resource investigations may mitigate against the effective integrated planning of water resource development.

8. The O&M Cells at the State level will increasingly set State policies, criteria and standards for O&M: monitor field operations at the basin and project levels to ensure consistency and the maintenance of standards; and evaluate performance to ensure that experience is fully shared across basins and schemes. Until basin-wide operations are fully established, it would also help ensure that scheme level operations are consistent with those of other schemes in the basin 1/ and would provide advice and support to scheme level O&M staff.

9. An important function of the O&M cell will be to set policies and approve operating rules to be used in planning and design of new projects.

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1/ Ideally, such an activity would be done by a basin-wide authority which would assess each year's water supply, allocate this among basin schemes, coordinate reservoir operations to maximize benefits (from power and other purposes as well as irrigation) according to basin-wide operating rules, and provide hour-by-hour coordination during periods of flood. Based on these allocations, the scheme level committee would decide on annual and seasonal operations, and the scheme O&M staff (the level of direct action and interaction with the users) would be responsible for
This will be particularly important in relation to the planning of NWMP sub-projects (para 6) and ultimately the O&M cells may take over full responsibility for the NWMP. In the meantime, and for investment projects indefinitely, the O&M cells will participate in evolving the operational plan for individual sub-projects, and in assessing the staff and facilities (communications, equipment, offices, shops, housing) required for project O&M. It would provide to the PPC cost estimates for the O&M of schemes under study and establish the nature of the water delivery service to be provided. For existing schemes (e.g. modernization, upgrading, etc), this would be done in close consultation with the scheme O&M staff and beneficiaries, and in new schemes in consultation with potential users.

10. Implementation of the NIMP will provide experience with improved O&M planning procedures at the scheme level. To assist the O&M cells in assessing this experience, and in evolving statewide programs and policies for O&M, the credit provides for a detailed review, to be carried out under Terms of Reference satisfactory to IDA, of existing procedures and financial requirements for operation and maintenance of irrigation projects and the potential for involving farmers in O&M. It is hoped that these reviews would lead to a mutually agreed program for upgrading O&M performance State-wide SAR, paras 6.15-6.17).

B. ANDHRA PRADESH

Overall Institutional Structure

11. The recent merger of the Irrigation and the IU & CAD Departments / has created a unified irrigation agency under the Secretary, Irrigation. The ultimate structure of this agency is still under discussion, but it is expected to evolve over time with two main wings (see Chart 1):

(a) A planning and construction wing, coordinated by the Engineer-in-Chief, responsible for the planning, design and construction of new investment projects; and

(b) An O&M wing, headed by a Commissioner (CAD/O&M) also in the rank of Engineer-in-Chief, responsible for the operation and maintenance of completed projects.

12. The Engineer-in-Chief (Construction Wing) will continue to be responsible for establishment matters, (staff will belong to a unified service although, over time, it is expected they will increasingly specialize, e.g. in design, construction, O&M, etc). He will also have responsibility for

1/ A Government Order merging the two departments into an "Irrigation and CAD Department" were issued on May 12, 1986. A merger committee has been established to recommend the detailed organization of the new department, and to allocate staff and responsibilities accordingly.
planning and budgeting, and for coordinating departmental matters. Chief Engineers will be responsible for:

(a) centralized activities (the Project Preparation & Monitoring Cell, Investigations and Water Resources, the Central Design Organization, 1/ the AP Engineering Research Laboratory and Mechanical) 2/;

(b) general construction and implementation (Major Irrigation, Drainage & Flood Control, Medium Irrigation & Inland Water Transport, Minor Irrigation, and Groundwater); and

(c) major individual projects (currently Nagarjunasagar, Sriramsagar, Sri Sailem and Telugu Ganga).

13. The Commissioner (CAD/O&M) will be assisted by a Chief Engineer (O&M Cell/Water Management) 3/ with line staff organized on a river basin basis (tentatively with Chief Engineers responsible for the Godavari and Northern Sector, Krishna any) with, depending on scheme size, the SE, EE or AEE in charge of reporting through an appropriate hierarchy to the respective river basin CE. Initially, the Commissioner is assuming responsibility for the O&M of the Sriramsagar project, and detailed recommendations have been forwarded to Government suggesting how responsibilities will be divided with the CE (Sriramsagar) (Construction). Once this has been achieved, and the experience evaluated, it is expected that O&M of other schemes will be gradually transferred from the respective existing CEs to the Commissioner. It is inadvisable to force the pace in these transfers but it is expected that it will be complete within, say, two to three years.

The PPMC and O&M Cell

14. Under the Andhra Pradesh Irrigation II Project (Cr.1665-IN/Ln.2662-IN), GOAP was committed to a review of the functioning of the PPMC 4/ by end December, 1986. This has essentially been done and it is proposed that the CE (PPMC) will have four major units under him (Chart 4) responsible respectively for Sriramsagar, Sri Sailem (the two projects included under the AP Irrigation II Project), the NWMP and the EEC-supported Medium Irrigation Project). Each unit will be financed under the respective project (thus only the costs of the NWMP circle under a SE will be met from the NWMP credit (SAR, Table 8). In addition, the CE (PPMC) has attached to his unit responsibility for the State's Dam Safety Cell financed from State funds.

1/ Reporting directly to the Engineer-in Chief.

2/ The Director General (WALAMTARI) currently should be included in this list but logically would report to the Commissioner in the longer term.

3/ In the longer term, the Director General (WALAMTARI) and the Director (Groundwater) may report to the Commissioner.

4/ In Andhra Pradesh, the PPC is known as the Project Preparation and
15. As currently established, the PPMC is responsible only for foreign-aided projects. For the NWMP, in addition to the formulation and preparation of sub-project proposals, the PPMC will assist scheme staff in implementation, monitor project implementation, submit regular progress reports and maintain project accounts (including requests for financial provisions and the collation of expenditures for reimbursement from IDA). It will also manage the funds included under the credit for special studies and programs designed to strengthen its capacities on specific subjects (SAR, para 3.11). To assist the PPMC in carrying out the engineering surveys, and the preparation of detailed designs and estimates needed for individual NWMP sub-projects, a special division has been created under the Designs Organization on secondment to the PPMC.

16. The O&M cell will be established under a Chief Engineer (Water Management/O&M) reporting to the Commissioner (CAD/O&M). The tentative organizational structure is given in Chart 4 and the staffing and related costs, which will be met from the credit, in SAR, Table 8). While the ultimate structure has yet to be finalized, it is expected that the O&M cell will have three units for operations (each corresponding to a river basin), one unit for maintenance, and an agricultural unit under a JDA. The CE position has already been created (it was previously the CE (Water Management) position in the erstwhile IU & CAD Department). It is expected additional staff will be appointed in 1987/88 and that the cell will reach full strength within two years.

Organization at the Scheme Level

17. Seasonal decisions are taken by the CAD organizations or, in their absence, by the District Irrigation Development Board (IDB) chaired by the Collector. Four CADAs have been created: for Nagarjunasagar Left Bank, Nagarjunasagar Right Bank, Sriramsagar and Tungabhadra respectively. Seasonal decisions are initiated at seasonal 'workshops' (or committees) held in the project area 1/ and attended by Government officials, farmers and their representatives. Recommendations adopted by the workshops are subsequently reviewed at the State level by the CAD Board (previously chaired by the Secretary IU & CADD), and by its Working Committees for each scheme, and appropriate Government orders are issued. In the case of the Tungabhadra complex, decisions on reservoir operations are taken by the Interstate Tungabhadra Control Board, but there appears to be some ambiguity at the sub-project level as to whether the CAD organizations or the respective IDB is responsible. For the Rajolibunda Diversion Scheme (RDS), for instance, the IDB has been responsible, with CADA officials participating in the IDB meetings.

18. The impact of the recent merger on the CAD institutions has yet to be clarified. Nevertheless, it seems probable that the present practice of seasonal workshops at the scheme level with subsequent review and approval at the State level, which has worked well, will be retained. In contrast, the

1/ Given their size, a number of meetings at different locations in the project area have been held.
role of the IDB in relation to specific schemes has not always proven satisfactory. Not only may a scheme fall within more than one district, but the IDB reviews irrigation matters throughout the district and may give inadequate or unfocused attention to the requirements of a specific scheme. For all NWMP sub-projects it has therefore been agreed that seasonal 'workshops' (or committee meetings) analagous to those for schemes with a CADA will be established to take management and seasonal decisions. Increasingly, as O&M is organized on a river basin basis, the decisions at a scheme level will be taken within the framework of basin level allocations and the final review and approval may be taken by a body comparable to the existing CAD Working Committees, but organized by river basin rather than by major scheme. 1/

19. With the merger of the previous Irrigation and IU & CAD Departments, many of the problems previously encountered in coordinating the activities of field level Irrigation and CAD staff will be resolved. A single O&M organization, ultimately reporting through an appropriate hierarchy to a basin CE (para 13), will be responsible for:

(a) system operations and water delivery from the diversion point to the Government outlet;

(b) maintenance and and minor construction work, including CAD works below the Government outlet; and

(c) contacts with the beneficiaries on irrigation matters, including such supervisory functions over farmer O&M activities below (and potentially above) the Government outlet as may be necessary.

Systematic linkages will be established with other Government agencies, notably the Agricultural Department (Annex 11), and consideration is being given to whether, for the larger schemes, an agricultural office (staffed by seconded AD personnel), immediately under the Administrator (SE), should be created to provide day-to-day advice to the scheme level O&M staff and to provide a direct link with the Agricultural Department.

C. KARNATAKA

Overall Institutional Structure

20. The Irrigation Department comes under the Secretary II in the Ministry of Public Works, Electricity, Irrigation and CAD. To date, staff have been transferable between irrigation and other public works (roads, buildings, public health engineering) but new recruits have in recent years had to opt for one or the other, and by end-1986 a specialist irrigation cadre will have been fully created. Under the Secretary II, Chief Engineers are responsible for:

1/ Essentially this function is performed by the Tungabhadra Control Board for schemes served by the Tungabhadra Dam, although in both Andhra Pradesh and Karnataka, State level CADA and District institutions also
(a) centralized activities (Water Resources Development, the Karnataka Engineering Research Institute, Mechanical, the WALMI and, to be established, the PPC/O&M Cell (see below));

(b) general design, construction and O&M (Irrigation North, Irrigation South and Minor Irrigation); and

(c) major individual projects (currently Upper Krishna, 1/ Tungabhadra and Hemavathy). (See Chart 2.)

In contrast to the newly established Andhra Pradesh structure, there is no clear separation between the planning, design and construction of new projects and the O&M of completed projects. Each Chief Engineer (apart from those responsible for centralized activities) allocates staff within his jurisdiction depending on requirements. Thus, while staff at lower levels tend to be assigned either to new construction or to O&M, even at the EE level they may have responsibilities for both. This organization only partially reflects river basin considerations although operations at the scheme level are unified even where the scheme falls in more than one District (e.g. Tungabhadra, Bhadra, etc).

21. The CADA Administrators report to the Secretary I in the same Ministry, but liaise closely with the Secretary II on all matters pertaining to system operations. Five CADAs have been established (for the Cauvery Commands, Bhadra, Tungabhadra, Ghataprabha/Malaprabha and Upper Krishna respectively), each headed by an Administrator, responsible for the coordinated development of the command area. In all cases other than Upper Krishna, where he has been a senior IAS official, the Administrator is an engineer of senior CE rank. The Administrator is assisted by staff seconded from other departments (Agriculture, Irrigation, Cooperatives) and is either Chairman or Secretary of the CADA Board (on which other Government agencies, local leaders and farmers are represented).

22. Largely for historical reasons, and in contrast to other States, the Director, (Groundwater) reports to the Secretary of Mines. Field staff are allocated on a district basis and are responsible for geological survey, groundwater monitoring, and public development of groundwater resources.

The PP/O&M Cell

23. A Project Preparation Cell (PPC) was established in 1985 with Bank assistance provided through the PPF included under the UP Tubewells II Project (Cr.1332-IN). It is headed by a Superintending Engineer, reporting to the CE (Water Resources Development Organization) and is responsible for the preparation of projects for submission to foreign financing agencies. In this capacity, it has had responsibility for the preparation of NWMP sub-projects although, given its fairly recent creation, it has depended to a considerable extent on the active participation of field level ID staff. The

1/ Recently as many as five CEs have been appointed for various aspects of
engineering surveys and the preparation of detailed designs and estimates for individual NWMP sub-projects have, in particular, been undertaken by the field ID staff, strengthened as necessary by reallocation of staff by the CE concerned.

24. In addition to a wide range of activities relating to water resources (including resource investigations, hydrology, inter-State water disputes, preparation and investigation of new (non-foreign financed projects), the CE (WRDO) is also responsible for establishment and personnel matters. With the creation of a separate Irrigation Cadre (para 20), this responsibility has assumed considerably greater importance since personnel matters were previously largely handled on a Ministry-wide basis. Given this work load, and the wish to give the PPC heightened importance, GOK intends to establish an expanded PP/O&M Cell under a separate CE, responsible initially for the preparation and monitoring of foreign financed projects (including the NWMP). Over time, it is intended that it will increasingly assume responsibility for the preparation of all projects. Its proposed structure is given in Chart 5 and the staffing and related costs, which will be met from the credit, in the SAR, Table 9.

25. While the creation of a PP/O&M Unit under a separate CE will provide increased authority to the unit, care will need to be taken in its future to ensure that:

   (a) all projects in the State, whether financed locally or by a foreign agency, are prepared to comparable standards;

   (b) project planning and preparation are fully consistent with both State level planning and basin planning; and

   (c) planning and investigations are mutually supportive.

State planning (preparation of the Five Year and Annual Development plans) is currently undertaken in the office of the Secretary II under the Deputy Secretary (Irrigation). Basin planning has still to be developed systematically although a Committee on River Basin Planning, chaired by a senior retired official and with the CE (WRDO) as Secretary, has been established. The CE (WRDO) also coordinates water allocations between projects in the context of his responsibility for interstate water disputes and discussions.

26. Initially, the PP/O&M unit will be responsible for formulation, preparation and monitoring of both investment projects (e.g. UKP) and the NWMP. In the context of the latter task, it will assist scheme staff in implementation, monitor progress, maintain project accounts, and manage the funds included for special studies and programs (para 3.17 of the Main Report). It will also increasingly help develop State policies, criteria and standards for O&M generally (para 8). In view of the Irrigation Department's present structure, and in particular the fact that construction and O&M are not clearly separated, no separate O&M cell (as in Andhra Pradesh and Tamil Nadu) is initially proposed. Over time however, and as its responsibilities expand, it can be expected that the PP/O&M cell will bifurcate, in particular if a similar bifurcation takes place in the State's field organization between staff responsible for planning design and construction of new projects, and those responsible for O&M. If this occurs, then the PP element
could develop into a fully-fledged basin and project planning unit, and similarly the O&M/ NWMP element into an O&M policy and support unit as in the other two States.

Organization at the Scheme Level

27. Irrigation decisions in Karnataka are taken by the scheme-level Irrigation Consultative Committee (established under the Karnataka (then Mysore) Irrigation Act of 1965). This committee comprises both official and non-official members (who may be farmers) nominated by the State, and may be chaired by the CADA Administrator, District Collector (for schemes falling wholly within one District) or such other member as may be nominated. Where the scheme falls in more than one district, this committee ensures that the differing interests are fully represented, and that discussions focus on the specific scheme under consideration. Involvement of the CADA Administrator and other CADA staff ensure coordination with the CADA Board which is primarily responsible for the systematic development of the command area. The CADA Board does not, however, have specific responsibility for seasonal irrigation decisions.

28. ID staff are responsible for all construction, maintenance and O&M and for this purpose are normally organized on a scheme basis. Only in the Upper Krishna Project have CAD works below the Government outlet been undertaken by CADA staff (normally seconded from the Irrigation Department). In other schemes, the ID has undertaken all these works according to a program agreed with CADA and with funds provided through the CAD budget. Problems of coordination between ID and CADA staff in relation to irrigation matters have therefore largely been avoided. CADA's responsibility for mobilizing farmer involvement may, however, have resulted in some ambiguity. Under the project, it is proposed that the ID increasingly assume responsibility for direct interaction with the farmer beneficiaries and for supervising farmer O&M activities below the Government outlet (Annex 12).

D. TAMIL NADU

Overall Institutional Structure

29. The Public Works Department, reporting to the Secretary (PWD), is responsible for both irrigation and buildings, and PWD staff, although usually having specialization in one or the other, are transferable between the two activities. The CE (Irrigation) is responsible for all major and medium irrigation schemes in the State, except for the construction of major new programs (currently only Periyar Vaigai being modernized under a Bank supported project 2/ (Cr.1468-IN/SF.16)) for which Special CEs may be appointed. Although the CE (Irrigation) is in principle responsible both for

1/ It is expected that a similar arrangement will also soon be introduced on the Upper Krishna project.

2/ O&M of the Periyar Vaigai scheme remains, however, the responsibility of the CE (Madurai) reporting to the CE (Irrigation) in Madras.
new projects (other than Periyar Vaigai) and for the O&M of completed projects, in practice the latter is his major preoccupation since Tamil Nadu has already exploited most of its available water supplies (Annex 3). With the expected appointment of a new CE (PPC/NWMP), responsible for the planning of all new projects and programs, the CE (Irrigation) will essentially only be responsible for O&M. In addition to the CE (Irrigation) and the Special CE (Periyar Vaigai), the Secretary (PWD) is supported by CEs responsible for Minor Irrigation, Groundwater and Buildings, and by the Directors of the Pondi Research Institute and the Irrigation Management and Training Institute (Chart 3). Field staff are organized on a district basis, reporting as appropriate to the respective CEs in Madras.

30. Tamil Nadu has had no CAD organization, and PWD staff are fully responsible for the O&M of all irrigation schemes, as well as for permanent interaction with farmers and for such supervision of their O&M activities below the Government outlet as may be required. However, in order to allow the State to obtain access to funds provided under the centrally-sponsored CAD program, the Agricultural Engineering Department (AED) in the Ministry of Agriculture was made responsible for construction of CAD works below the Government outlet. In this context, and to avail itself of the funds provided for the 'warabundi' program, AED has also undertaken some promotion of farmer organization and related activities. The involvement of AED in command area development, if only on a temporary basis (once the CAD works are completed, AED staff in principle are withdrawn), has created problems of coordination with PWD staff. To avoid these problems in future, a Government Order has recently been issued (dated May 26, 1986) instructing all AED staff involved in CAD activities to work under the direction of the respective SE for the district, and to implement such activities according to a program laid down by him.

The PPC and O&M Cells

31. The PPC in Tamil Nadu was initially established with assistance from the Bank (SAR, para 3.27) to prepare the proposed Cauvery Delta Modernization Project. For this reason, it was located in Thanjavur under a Director (SE rank), with a coordinating office located in Madras under the direction of the Officer-on-Special-Duty (OSD) (Cauvery). It has been responsible not only for general preparation activities but also for the detailed designs and estimates of proposed projects. Initial preparation of NWMP sub-projects was entrusted to the OSD (Cauvery) working with scheme officials and subsequently a special division (Tirunelveli) and a special sub-division (Sathanur) were established to undertake detailed preparation.

32. Both the PPC and the OFD (Cauvery) report to the CE (Irrigation). However, GOTN intends to consolidate all project preparation and planning under a separate CE responsible for the preparation and monitoring not only of foreign financed projects (Cauvery Modernization, NWMP) but also locally financed projects. The proposed structure of the PPC/NWMP cell is given in Chart 6 and the staffing and related costs, which will be met from the credit, in SAR, Table 10. Creation of this separate organization under a CE will provide increased authority to the Unit. In effect, it will assume responsibility for programming all major and medium irrigation development in the State, as well as for surveys and investigations in relation to specific
projects. Care will need to be taken that such project planning and preparation are placed within a basin framework. Basin studies for the Periyar-Vaigai, Ponniam and Thambaraparani basins have been initiated with UNDP assistance in the Institute for Water Resources which is also responsible for maintaining basic hydrological and other resource data. The Director of this Institute reports to the CE (Groundwater). Consideration should be given to how the activities of the CE (PPC/NWMP) and those of the Institute can best be coordinated.

33. With the appointment of a separate CE (PPC/NWMP), the CE (Irrigation) will essentially confine his activities to the O&M of completed projects. Since most water resources have been exploited in the State, O&M is the major activity. To assist the CE (Irrigation), a State level O&M policy and support unit will be developed in his office under the Senior Deputy CE (O&M). The proposed structure of this unit is still under discussion but a tentative organization is presented in Chart 6 and the proposed staffing and related costs, which will be met from the credit, in Table 3(b). It is expected that the unit will be fully staffed within two years.

Organization at the Scheme Level

34. Field operations in Tamil Nadu are organized predominantly on a District basis. Seasonal decisions are normally taken by the District Irrigation Committee (DIC) chaired by the District Collector. Where a scheme falls wholly within one district (e.g. Thambaraparani in Tirunelveli District or Kodayer in Kanya Kumari) this may be broadly satisfactory; but where a scheme falls in more than one district (e.g. Sathanur) inconsistencies and conflicts may arise. Furthermore, the DIC is concerned with many other issues which divert attention from those relating to the scheme concerned. Assurances will therefore be obtained from GOTN that a scheme level committee (comparable to the seasonal workshop in Andhra Pradesh (para 18) and the Irrigation Consultative Committee in Karnataka (para 27)) will be established for all NWMP sub-projects.

35. PWD operations are similarly organized on a district basis, and PWD staff may have a range of responsibilities outside the major scheme concerned (maintenance of buildings, minor irrigation, etc). Where a scheme falls in more than one district, operations may be divided between two or more district PWD offices. To ensure unified operations, assurances will be obtained from GOTN that a single PWD organization will be responsible for the operation and maintenance of each NWMP sub-project. In most cases, it is expected that this will be the office in the District accounting for the major part of the command. In the longer term consideration will be given to reorganizing PWD operations on a basin rather than a district basis.

36. With the recent decision that all AED activities in the command will come under the control of the PWD (para 30) the latter will be effectively responsible for all system operations, maintenance and minor construction.

1/ The Radhapuram Canal sub-command in the Kodayer system is located in neighbouring Tirunelveli District and for this reason is represented on
below the Government outlet, and contacts with the beneficiaries on all irrigation matters. Provided a scheme-wide committee and O&M organization are established, problems of coordination and integration of O&M activities should be avoided.

E. GOI

37. The GOI Water Management Cell (WMC) in the Ministry of Water Resources was established in late 1984 to help prepare and promote the NWMP. Its technical staff, comprising a Chief Engineer (WM) and a Joint Commissioner (O&M), were actively involved in all stages of project preparation, both in discussions with the States on the overall project design and in relation to the preparation of individual sub-projects. Under the project, its staffing will be strengthened and it will be responsible for coordinating overall project implementation, and for providing administrative and technical support to the NWMP Appraisal Committee. It will be the focal point for ensuring that all States apply the guidelines in a systematic and comparable manner, and for organizing workshops and training programs involving more than one State. It will initiate discussions with additional States on their potential participation in the program and help identify pilot projects. It will also be responsible for preparing the Project Completion Report. The SAR, Table 9 summarizes the staffing and related costs, which will be met from the credit.

F. APPROVAL AND CLEARANCE OF NWMP SUB-PROJECTS

38. Primary responsibility for selection, preparation and approval of sub-projects will rest with the State Governments concerned. However, GOI clearance will be required to ensure consistency and adherence to NWMP criteria. Sub-projects will be prepared by the respective State PPC and will be cleared as follows 1/ (Schedule A under the Credit Agreement).

(a) An initial Scheme Summary covering the background to the proposed sub-project and an outline of the operational issues to be addressed will be presented to the NWMP Appraisal Committee in GOI. The purpose of this summary would be to obtain preliminary clearance of the proposal and hence confirm eligibility of detailed preparation costs for financing under the NWMP.

(b) Following clearance of the Scheme Summary, the State PPC, working closely with the State O&M Cell, the project authorities and other Departments and Agencies as appropriate, will prepare a full Scheme Report in accordance with the guidelines laid out in Annex 4.

1/ These procedures will not be needed in relation to the three sub-projects appraised by IDA during formal appraisal of the NWMP: Rajolibunda Diversion Scheme in Andhra Pradesh, Vanivilas Sagar in Kar-
(c) State Technical and Administrative Clearance will be by a Committee or Committees established at the State level, and will be provided in close consultation with the beneficiaries and following any local discussions and approvals as may be decided by the State Government. In Karnataka, a single committee will be established, chaired by the Secretary II (PW, Irrigation, CAD and E Dept) comprising members drawn from other technical agencies and coopted scheme level staff. In Andhra Pradesh and Tamil Nadu, technical review will be by a committee chaired by a senior ID engineer, and administrative clearance will be by a committee chaired by the Secretary Irrigation/PWD.

(d) GOI Clearance will be by the NWMP Appraisal Committee in the Ministry of Water Resources (MWR), chaired by the Additional Secretary, Water Resources and comprising appropriate officials drawn from the MWR, CWC, the Ministry of Agriculture and ICAR.

(e) IDA Approval would be based on the final scheme reports following GOI clearance. An understanding will be reached with GOI and the States that IDA will be kept informed of the processing of scheme proposals.

39. As indicated in (c) above, the form of the State approval, and the nature of the local discussions with the beneficiaries, will be flexible so as to respond to the requirements of the different States. Formal approval by local bodies (e.g. the District Irrigation Committee) would raise difficulties which may be extraneous to the primary purpose of the proposed project. Nevertheless, consultation with the beneficiaries is an essential part of formulating a scheme proposal and where, as in the case of the Sathanur project in Tamil Nadu, significant changes in the operating rules are envisaged, complex local discussions with both the farmers and the District Authorities may be required.

40. Proposals by non-participating States will be cleared and approved in a comparable manner, although, since this will be confined to one or two pilot projects, it will not be necessary for the States to establish a formal committee or committees at the State level ((c) above).
INDIA
NATIONAL WATER MANAGEMENT PROJECT
PPC/O&M Unit: Karnataka — Organization Chart

SECRETARY I
PP, CAD&E

CE (WRDO)

SE (PPC)
EE EE
AEE2 AE2
AE4 AE4

SE (O&M)
EE EE
AEE2 AE2
AE4 AE4

SE (INVESTIGATIONS)

SE (CAUVERY)

AGRONOMIST

SE (HYDROLOGY)

ECONOMIST

TECHNICAL UNIT

REGISTRAR

ADMINISTRATIVE ACCOUNTING OFFICE

DRAWING OFFICE & OTHER STAFF

World Bank — 30822.2

Chart 4
INDIA
NATIONAL WATER MANAGEMENT PROJECT
PPC and O&M Units: Andhra Pradesh — Organization Chart

SECRETARY IRRIGATION

ENGINEER-IN-CHIEF
ADMINISTRATIVE BUDGET,
NEW PROJECTS, ETC.

CE (PPMC)

DCE (ADMINISTRATION)
EE (SRIRAMA SAGAR)
EE (SRI SALEM)
EE (EEC TASKS)
EE (NMWP)

ENGINEER-IN-CHIEF
O&M

CE (WATER MANAGEMENT/O&M)

DCE (ADMINISTRATION)
SE (MAINTENANCE)
SE (OPERATIONS)
SE (SYSTEMS ANALYSIS)

AGRICULTURE/ECONOMICS
AGRICULTURE/ECONOMICS
AGRICULTURE/ECONOMICS
AGRICULTURE/ECONOMICS

SUPPORT STAFF
ENGINEERING SUPPORT STAFF
ENGINEERING SUPPORT STAFF
ENGINEERING SUPPORT STAFF

PROJECT A
PROJECT B
PROJECT C, ETC.

AGRICULTURE/ECONOMICS
GODAVARI
KRISHNA
PENNER

World Bank — 308223

Chart 6
Agricultural Research in India

1. Agriculture is constitutionally a State subject in India, and thus agricultural research is primarily a State responsibility. State Agricultural Universities undertake this function on behalf of the State government and receive the main part of their financial support from the State, mostly in the form of non-plan grants which are often inadequate for their effective functioning. The Indian Council of Agricultural Research (ICAR) serves as a national coordinating and supporting agency, and provides additional assistance to SAUs in performing their duties.

The Indian Council of Agricultural Research

2. The Indian agricultural research system is a cooperative program between the Government of India (GOI) and the individual States. GOI's contribution is funded through ICAR. The latter is not only active in managing research programs of its own through its Central Institutes but also serves as the national coordinating body for research carried out in the different States.

State Agricultural Universities

3. The SAUs were established with the objective of creating a system of scientific education and research which would serve the needs of the farming community. Their basic objectives were similar to those established under the United States of America's Land Grant College System, and several U.S. universities provided teams of technical advisors to assist in the planning and development of the first SAUs. Their development has been very uneven, resulting from differences in the political environment, the strength of university leadership, and the extent of State government support. Most SAUs, including those in Andhra Pradesh, Karnataka and Tamil Nadu have, however, now matured into vigorous institutions, capable of meeting most needs of their farming communities. They have been assisted in this by two IDA supported projects: the first and second phases of the National Agricultural Research Project (NARP I and NARP II, Cr. 855-IN and Cr.1631-IN).
National Agricultural Research Project

4. NARP I (effective in January 1979) had limited objectives, designed to strengthen the capability of the SAUs to conduct zonal research in support of reformed statewide agricultural extension projects. ICAR supported Central Research Institutes, and the All India Coordinated Research projects, were excluded from the project, as ICAR had adequate funds at that time to finance these programs. The project focused, in particular, on research oriented towards the needs of the main agro-ecological zones. Special emphasis was given to foodgrains (cereals and pulses) and oilseeds, especially those grown under rainfed conditions, and on the integration of cropping patterns and animal husbandry practices. A main feature was the decentralization of research away from the main campus through the establishment, where not available, of research stations and sub-stations in the 121 agro-ecological zones identified in the country. In addition, regular and effective contact was established between research and extension through the fortnightly training and monthly workshops. The expression of research needs by the extension service on behalf of the farming community has become an effective tool exerting pressure on SAUs to deliver farmer-oriented technology.

5. NARP II, which became effective in April 1986, has extended and broadened the approach promoted under NARP I, having the following components:

(a) Completion of unfinished NARP I sub-projects (those that have not completed five years of operation);

(b) Expansion of the scope of NARP to cater to the priority needs of each agro-ecological zone, including: (i) new areas of research such as irrigated farming, animal-drawn farm implements, horticulture, commercial field crops, agro-forestry, and animal nutrition, (ii) programs for field testing and refining research results, and (iii) facilities at Regional Research Stations for training Subject Matter Specialists of the DOA;

(c) Provision of funds for individual research activities on priority topics emerging or identified during project implementation and not covered under (b) above;

(d) Strengthening of research administration of two State Agricultural Universities; and

(e) Continued funding of the ICAR Project Unit, including provision for training of research scientists.

6. The main emphasis is on the relevance of the research programs to farmer needs. In order to make this possible, each of the Zonal Research Stations is required to prepare a basic Status Report for the station service area. This Status Report, which includes a detailed description of agro-climatic features and water management operations, tries to identify the different farming situations from the farmer perspective. It also describes the adoption pattern of recommended technologies. Based on this analysis, research strategies and programs are to be developed which will form the
basis of new or additional zonal sub-projects to be sanctioned and financed by ICAR under NARP II. Research support for NWMP would be mainly adaptive and operational in nature and will be structured and financed as part of the NARP zonal (new or supplemental) sub-projects.

The ICAR Coordinated Project for Research on Water Management

7. The ICAR Coordinated Program covers 7 agro-ecological zones at 34 locations in 18 states representing 29 command areas. The program is implemented by a staff consisting of 1 Project Coordinator, 2 Zonal Coordinators, 141 Senior Scientists, 152 Junior Scientists and about 250 support staff. Its major research efforts have concentrated on developing optimum irrigation schedules for different crops and cropping systems, including inter-cropping. The same tests have often been run for kharif and rabi (sometimes also for summer) in order to find the most efficient and economic use of irrigation water. In many experiments, fertilizer levels were included to determine the interaction of irrigation and fertilizer so as to improve overall crop water efficiency. Experiments have been conducted to determine the reduction in crop yields with different durations of submergence/saturation during the growth phases of the crops, so as to work out field drainage requirements. Additional observations taken on these experiments have shown that, with shallow water tables, crops can often meet their consumption requirements (evapo-transpiration) to a large extent from the capillary rise from the water table and the adjoining saturated zone.

8. The main aspects of ICAR's coordinated crop water management research which have yielded usable results for further applied and operational research are:

(a) irrigation scheduling and water balance of crops, inter-cropping systems and crop sequences under constrained irrigation conditions;

(b) methods of irrigation and field levelling;

(c) reduction of percolation losses from paddy fields;

(d) monitoring of groundwater table development;

(e) contribution of groundwater table to crop growth and evapo-transpiration; and

(f) on-farm water management.

9. Most of the experimentation has been done on station and the results are mostly site specific, except for those of the modest on-farm water management research program. The experimental results obtained have shown great variability between locations as a result of differences in: (a) soil characteristics; (b) effective rooting depth and intensity; (c) crop specific fluctuations of the ratio between potential and actual evapotranspiration; (d) field irrigation methods; and (e) soil moisture changes resulting from upward or downward water transmissions.
10. Operational on-farm research in paddy systems has demonstrated significant water savings with: (a) intermittent water supply; (b) shortening of supply time from head to tail below the outlets; and (c) shortening of the field preparation and transplanting period.

11. Methods of improved field layouts and landshaping using animal drawn equipment have also been effectively developed and demonstrated in a few command areas.

Status of Research in Participating States

12. The SAUs which would participate in support of the NWMP (in Andhra Pradesh, Karnataka and Tamil Nadu) have strong dynamic leadership, a number of well trained and experienced scientists, and have made satisfactory progress in implementing NARP programs. Research has been decentralized as per the NARP concept and all the Zonal Research Stations have been established. TNAU has Water Technology Centers at Coimbatore and Madurai, and has initiated effective operational research in the Periyar Vaigai project. Karnataka has performed effective crop water management research in the past and is currently conducting operational research in the Upper Krishna project. Andhra Pradesh has not yet started with adaptive research but its Zonal Research Station at Guntur in the Krishna/Godavari zone has produced cotton and pulse varieties for the Nagarjunsasagar project which suit the on-going changes in crop water management and cropping patterns in this project.

Methodology for Crop Water Management Research

13. The research methodology to be used would be a function of the research needs perceived not only by farmers and extension workers, but also by those who manage irrigation schemes. There are a number of ways in which this operational research could be designed according to the needs of users, beneficiaries and managers. Its major objectives would be to:

(a) generate technology which farmers can adopt within the technical and operational limitations of existing schemes;

(b) diagnose operational constraints with a view to improving management and the use of water;

(c) measure the impact of changes in water management on cropping patterns, and of the timing of farm operations which follow from a change in cropping patterns;

(d) conduct research on farmers' fields with alternative crops and cropping sequences in order to prepare contingency cropping patterns in case of water shortage;

(e) establish crop growth and yield response to different levels of water supply over the total growing periods for specific crops and crop sequences; and
(f) record and monitor factors influencing the supply of water which could disturb and change the underlying assumptions for designing water delivery schedules.

These could include occurrence, frequency and geographical distribution of local rainshowers, temporary or permanent shallow water tables, and residual soil moisture reserves at the beginning and end of an irrigation season. In addition to these objectives designed mainly to improve scheme management, there are a number of research topics which would mainly affect farmers directly (on-farm crop and input research).

14. These water management objectives require a methodology which covers whole hydraulic units subject to the same operation system, such as outlet sluice commands, distributaries, or for example, whole tank or tubewell commands. Instead of artificially introducing variability in irrigation conditions, the variability of real situations would be used to establish correlations between certain farming (water management) situations and cropping patterns, timing of operations, quantity and quality of inputs used other than water and, finally, yields and overall farm productivity. This variability will be further enhanced by selecting certain hydraulic units (for example commands of outlet sluices, minors, or even distributaries) and establishing an improved water management system in those commands. Results would then be compared with those in an unimproved situation to see how farmers respond in both systems.

15. This approach has major advantages over the classical controlled type of experimentation in the sense that the farm management factor can be introduced as an independent variable. The latter is an indication of how farmers endowed with equal resources (land, equipment, bullocks, labor) optimize the use of these resources with regard to farm output. In operational research, with a strong orientation toward improving water management through better farm management, the isolation, definition and quantification of the factor of farm management is essential.

16. The major operational research tasks would be: diagnostic analysis of the system (minor, distributary, tank command), investigation of the way water delivery works in relation to design, and evaluation of farmer response. Constraints associated with water availability, farm size, inputs and marketing opportunities would be identified. Where is is not possible to analyze a full command area in this manner, a stratified sampling technique would be adopted. Observed cropping patterns, methods and timing of field preparation, sowing and harvesting, and yields, would be correlated with the operational features of the irrigation system, such as the actual timing and quantity of water scheduling, the reliability of water delivery and communication between the Irrigation Department and farmers. Complementary socio-economic data on farm size, number of holdings, labor and equipment availability, opportunities for off-farm labor employment, marketing opportunities etc., would be analyzed. The results could be used as part of project preparation and a a reference point for further monitoring and evaluation work.
17. This diagnostic and yield gap analysis, started in a modest way with the Status Reports prepared under NARP, would be extended and undertaken in more detail for command areas located within the service territory of the Zonal Research Station so as to establish:

(a) The major yield determinants under the actual farming and water supply situation;

(b) The constraints preventing adoption of recommended technology; and

(c) Farmers' innovations in the field of irrigation and drainage technology and their use of the system to their best advantage.

18. Elements of both the benchmark survey and the diagnostic and yield gap analysis would be updated every two years. Where the Irrigation Department or CADA is responsible for monitoring the timing and quantity of water delivery, the SAUs could measure the impact of water management on changes in cropping patterns, timing of farm operations and farm output.

Water-balance Studies

19. The conjunctive use of groundwater (either from wells or by direct consumption through capillary rise) in meeting crop water requirements would be studied for canal and tank commands and well-irrigated farms. Water-balance studies would be undertaken for well defined command areas where interference from other sources, such as run-off and groundwater seepage from adjacent areas, can be excluded. So far, very limited research has been undertaken in India on this subject (research in Haryana is an exception) despite an alarming rise in groundwater tables and increased waterlogging in many commands. These problems clearly indicate that the combined contribution of rainfall and irrigation water is often in excess of crop water requirements. Techniques for water-balance studies and, in particular, for groundwater movement, have still to be developed in India. It would be advisable for the SAUs and Water Technology Centres to seek association with specialized research centres or firms overseas which have built up expertise in this field. Moreover, SAUs should include hydrologists in their water management research teams.

20. Research on new crops, varieties, cropping sequences, agronomic techniques, fertilizers, etc., for command areas would be carried out on farmers' fields within the technical and operational limitations of a command area. These farmers would be selected in unimproved as well as improved outlet commands. In fact, improved water management in one or more outlet commands or minors would be part of the experimentation. A good example is the work started by ICAR in the Bhavanisagar command and the Water Technology Center of TNAU in the Periyar Vaigai project. One of the most promising results has been the development of contingency plans for management in case of water scarcity, which could find a wide application in other command area. The same would be possible for crops and cropping patterns.
Research Priorities Required for Agricultural Planning in NWMP Projects

21. Site specific information on soils is inadequate in all initial projects. Additional detailed soil surveys at a scale of 1:10,000 at least, would have to be implemented over time to assess the suitability for irrigation, crops and water delivery schedules. The factors to be determined are:

(a) soil texture and structures;
(b) permeability and percolation rates;
(c) soil depth available for root development and occurrence of hard layers impeding rooting development;
(d) determination of water holding capacity;
(e) soil acidity and electrical conductivity, indicating salinity and alkalinity hazards; and
(f) slopes and micro-relief.

22. The occurrence of permanent or perched water tables and temporary ground water flows on shallow and sloping lands overlying low permeable strata should be described and mapped on irrigation maps of scale 1:10,000. Similarly, areas with impeded drainage and waterlogging need to be surveyed and mapped to indicate the quality of groundwater and its effect on soil salinity and/or alkalinity.

23. The prevailing cropping systems such as rice-based, rice-ID, pure ID crops, tree crops and mixed tree/ID crops, need to be inventoried and mapped, using irrigation maps of a scale of 1:10,000 or larger.

24. Cropping calendars such as the timing of field preparation and planting in relation to rainfall and current water scheduling, and availability of animal and manpower need to be analyzed. Actual water availability from rainfall and irrigation should be compared with requirements of crops and cropping calendars. New cropping sequences and systems would have to be evaluated against current available energy and manpower on the farm and additional requirements to be assessed. For example, coconut expansion in Karnataka is explained because of the steady incomes and low labor requirements of this crop, and as a consequence of the accumulation of the necessary investment capital by the farmers.

25. The economic and financial consequences of water management systems and their effect on subsequent cropping patterns, yields and farm incomes would have to be monitored by the farm economists of the crop water management teams. In particular, the timing of operations needs to be adequately recorded and analyzed. If, for instance, in an area with similar production constraints (e.g. poor soil, irregular rainfall or inadequate irrigation), 500 farmers are selected, all with the same farm size and dispersion of holdings, the same number of traction animals, tillage equipment and family labor, the farm output and financial results of those 500 farmers will show a very wide range of variability with differences up to 200% or even more. The variations in farmer output (yields and cropping patterns) are most often due
to the timing of the various farm operations. A farmer's judgement on the optimal use of his resources could be inspired entirely by his need to maximize farm output under the given constraints and risks. On the other hand, personal considerations such as time off for religious or communal duties, and off-farm economic activities, could influence his judgement. Nevertheless, the farm management factor exists, and can be identified and rated in each series of farm observations. Another management factor which needs to be assessed is the condition and availability of inputs such as farm equipment, traction animals, seeds and fertilizer, so that they can be used when the farmer judges the time is right.

Research Priorities for On-farm Research

26. Soil tillage and land preparation of paddy land, as well as for ID crops, are still mostly done with the country plough and local narrow or levelling plank, and are open for considerable improvement. Implements adapted to local soil conditions, such as animal drawn reversible ploughs, ridgers, planters, and fertilizer drills suitable for various ID crops, need to be developed and tested under farming conditions. In addition, implements for landshaping to suit the particular irrigation requirements of crops and soils are urgently needed.

27. In conjunction with improved implements, techniques for appropriate landshaping such as graded contour borders, wide bed-furrow or ridge furrow, border-cum-furrow or border-cum-corrugation, need to be tested on farmers' fields. Water application to tree crops could be greatly improved by low cost gravity drip systems substituting for basin irrigation. Crop specific cultivation practices (such as direct sowing, dibbling of pre-germinated rice seeds in the mud, and traditional transplanting) would be compared under farmers' conditions. For ID crops, available technology on field preparation methods, plant spacings adapted to the selected field, preparation methods and optimal timing of sowing, need first to be screened and tested on research farms in the command areas, and the most promising technologies further tested in on-farm trials. The same approach would be followed for testing different crops and cropping sequences.

28. Varietal research and testing would have to focus on the need to shorten crop growth duration, and hence water consumption, to respond to the constraints imposed by the water scheduling systems adopted. This varietal testing would consist of initial screening on research farms located in the command areas selected for inclusion in NWMP, and testing of the most promising varieties on farmer's fields.

Research Programs in Support of NWMP

29. Andhra Pradesh. The major irrigation command areas in Andhra Pradesh are Nagarjunsagar, Sriramsagar and Tungabhadra Projects. The Zonal research Station at Jagtial in Northern Telangana is preparing an adaptive research program in crop water management, which would include an adaptive research farm in the Rajolibunda Diversion Scheme. This could be the Kurvapa seed farm located in D29, the sub-station in Rudrur, Nizambad. In addition, distributaries would be identified in the RDS and Tungabhadra commands (in consultation with ID and DOA) for operational research as described above. Similarly, an adaptive research screening farm and appropriate distributaries
are being identified by the Agricultural Research Station at Garikapadu (at Guntur) for the Nagarjunasagar right canal, although similar facilities for the left bank canal command areas are yet to be identified. The Zonal Research Station at Nandyal would identify and prepare an adaptive research program for the Srisailam Project and a new project to be developed over the next ten years with IDA/Bank assistance (Ln.2662-IN/Cr.1665-IN).

30. **Karnataka.** The University of Agricultural Sciences (UAS) in Bangalore is preparing adaptive research programs for the following command areas including all those selected for the NWMP:

- Upper Krishna Project – Sub-station Trabhavi
- Vanavilas Sagar Project – Sub-station near Hiriyur
- Bhadra Project – Sub-stations at Honnaville and Kathalgere
- Tungabhadra LB – Sub-station at Siruguppa
- Malaprabha Project – Zonal Research Station near Dharwar.

Preparation of these programs is in an advanced stage as part of the supplemental zonal sub-projects to be financed under NARP II.

31. **Tamil Nadu.** TNAU is preparing supplemental zonal sub-projects which would include adaptive research programs for crop water management in the following zones:

(a) North Eastern Zone: Zonal Research Station at Vridhachalam to service well-irrigation, and the Sathanur Project in which well-irrigation is an important water source.

(b) Cauvery Delta Zone: Zonal Research Station at Aduthurai and the Soil and Water Management Institute at Kattuthottam, Thanjavur, to service the Cauvery Delta.

(c) Southern Zone: Zonal Research Station at Arruppukottai and the Water Management Institute at Madurai serving Periyar Vaigai command and the paddy experiment station at Ambasamudram to service the Thamraparani command area.

(d) The Kodiyar project area which would receive research support from the Rice Research Sub-station at Tirupathisaram.

32. The draft of the proposed research programs will be sent to ICAR and the Association for review before finalization.

**Institutional Arrangements for Crop-Water Management Research**

33. Given the interactions with other line departments such as Irrigation Department, DOA, and last but not least, the farmers, in the field of operational research, a clear definition of the responsibilities and accountabilities of each of the partners is necessary. At present, crop water management research is conducted by ICAR, IARI and a number of SAUs. Future partners in operational research could be the Irrigation Department or CADA, DOA, individual farmers or farmers' organizations and private firms. Without this interaction between research below the outlet by SAU and DOA, and
management above the outlet by the Irrigation Department, research efforts would have limited impact. The same applies not only to research in canal commands, but also to that in tank commands, tubewell or riverlift commands or even farmers' own shallow wells wherever they occur in NWMP sub-projects. The inter-actors might not always be the same, (for instance, the Irrigation Department is not involved in on-farm shallow wells, small tanks and private tubewells) and in these cases the research team of DOA and SAU would work directly with the farmers or Minor Irrigation Department. Alternative methods of water distribution and methods of analyzing and managing water on minors, distributaries and main systems as a whole are not widely studied, analysed or taught. Simulation studies carried out in the context of preparing operational plans under the NWMP represent one approach, but ground verification by SAUs would also be necessary.

34. ICAR is providing financial and technical support for Crop Water Management research directly to the SAUs. This is mostly in the form of the Coordinated Project for Research on Water Management which is operated at 35 centers located at the main campus or Zonal Research Centres of the SAUs. No formal arrangements have been established as yet for joint research arrangements with other agencies, such as Irrigation Departments, CADAs and DOAs as suggested above. However, the first steps have been set in the context of the NWMP to assure cooperation and establish a mechanism whereby the SAU becomes a regular partner in the preparation of modernization or management improvement projects. This can best be achieved by involving the SAUs in the diagnosis of current schemes jointly with the Irrigation Department, and DOA in the identification and preparation of new sub-projects to be considered for inclusion under NWMP. The SAU task would be to:

(a) review the proposed improvements in water management;

(b) support the management improvement through operational research, preferably in the projects where modernization or management improvement is the major objective; and

(c) evaluate the impact of improved water management on cropping and patterns, timing or operations and yields.

35. During the implementation of water management improvement programs, operational research is essential to develop and support changes in water scheduling, cropping patterns, crops and varieties, and onfield application techniques which have to accompany the changes in crops and cropping patterns. Since farmers are essential partners in the operational research and their group cooperation is required (for instance when it comes to experimenting with whole sluice commands), the DOA agents (e.g. VEWs), who are the most directly in contact with the farmers, become essential partners. They should assist with the creation of outlet user groups or associations and supervise on a frequent basis the on-farm experiments in the same manner that they are involved with other on-farm trials.

36. The role of the Irrigation Department in Operational Research would be four-fold:
(a) To review the research program on its merits. Since they are going to be a "beneficiary" as well as a partner in the operational research program, their preferences for research topics as well as location should be heard and considered;

(b) To become a full partner when it comes to the diagnostic analyses of a scheme and to be fully responsible for all aspects concerning water delivery;

(c) To participate in actual experimentation with water scheduling. For instance, in certain selected outlet commands, minors and distributors they would be responsible for the agreed mode of operations; and

(d) As part of their normal monitoring responsibilities, to measure and time the flows distributed to each part (distributary, minor) of the system.
Agricultural Extension in India

1. Soon after independence, GOI began sponsoring a number of programs designed to meet the need for more effective, country-wide agricultural development; the Community Development Program in 1952, the National Extension Service Blocks in 1953, the Intensive Agricultural District Program in 1960, and the Small and Marginal Farmers Development Program in 1969-70. Despite their proliferation, these programs covered only a small portion of the farmers, generally the wealthy. Recognizing that a new approach was required to achieve a more broadly-based increase in agricultural output, and in response to changing rural and administrative conditions, GOI, with IDA assistance, introduced an approach (tried earlier in other countries) which is generally known as the "training and visit system" (T&V). It was first tried in India through pilot projects in the Rajasthan Canal Command Area Development Project (Cr. 502-IN, 1974) and in the Chambal Command Area Development Project in Madhya Pradesh (Cr. 562-IN, 1975). Since 1977, it has been adopted by an increasing number of states on a statewide basis. It aims at increasing productivity on farms by simultaneously addressing:

(a) the transfer of new agricultural technology from research to the farmer; and

(b) feedback from the farmer to research and other government organizations to ensure research responds to actual farm problems.

Some of the changes introduced are organizational (single-line control, exclusive responsibility), others are operational (fixed, regular contact between farmers and extension, coverage, mobility, housing in the field), and still others relate to the linkage between research and extension (regular meetings and workshops of extension and research staff, systematic feedback of farmers' problems and responses to research).

2. Under the system of multi-purpose field workers which the T&V system replaced, extension personnel were burdened with heavy paper work and such non-extension duties as input delivery and administration of various subsidized schemes. These tended to dissipate extension efforts and divert attention and resources for the primary extension purpose. There were usually too few staff to cover the farming community adequately. They lacked mobility to reach farmers systematically and regularly, had practically no
training in relevant technology, and saw limited prospects for advancement. Most extension personnel had low status, low pay and poor morale. In addition, there was virtually no linkage between extension and research. Without this linkage, it is difficult to justify the considerable investment being made in agricultural research. Improved technology is of little benefit if it cannot be made available to farmers and, conversely, it is difficult to develop useful research unless there is sound feedback between farm and research, both roles for extension.

3. Over the past ten years, considerable efforts have been made to improve agricultural extension and research. Experience has confirmed what was recognized when the T&V approach was first introduced on a large scale; that in a democratic state with a well-entrenched bureaucracy, institutional change takes time, especially where large numbers of people are involved. The 16 states which have introduced, or are about to introduce, improved agricultural extension with IDA assistance, will eventually reach about 70% of India's farm families. In these states, there are to be some 66,000 village extension workers (VEWs), 8,800 agricultural extension officers (AEOs), 3,300 subject matter specialists (SMSs), 900 sub-divisional agricultural officers (SDAOs); 60 assistant SDAOs, 400 district agricultural officers (DAOs) and assistant DAOs, and 60 zonal joint directors and additional directors of agriculture. The extension service represents only a small part of the total civil service in any state (e.g., in Andhra Pradesh only about 1%) but because of the close and often unique field relationship with farmers (who represent the vast majority of every state's population), agricultural extension is particularly vulnerable to outside pressures for purely non-technical reasons. Although geared to existing institutions, substantial reorganization was needed in all states to deal with the major problems experienced under the former structure. The new system also called for major attitudinal changes on the part of extension staff, farmers, agricultural researchers and government officials, both within and outside departments of agriculture. Given these circumstances, as experience with these projects confirms, firm commitment at government level and strong departmental management are central to successful implementation.

The T&V System: Main Characteristics

4. The training and visit (T&V) extension methodology provides farmers, on a regular and systematic basis, current advice on farming practices best suited to their specific conditions, emphasizing proven practices with immediate impact on production and income. It is accomplished by a regular system of training and of visits by field staff, supported by professional advisors from within the state's Department of Agriculture and agricultural research institutions. The system calls for a single line of command from the Director of Agriculture to the village extension worker (VEW) and the merging of all agricultural field staff, including those engaged in crop-specific agricultural development programs, in a unified service, employed exclusively on agricultural extension. To reflect their exclusive role, such workers are called VEWs. Non-agricultural village level activities are handled by the village level workers (VLWs) with the Community Development Department, and other staff.

5. The number of farm families covered by every extension worker varies depending on population density, accessibility, intensity of farming and
other measures of need. Normally, between 700 and 800 families are served by a VEW, divided into eight groups each visited regularly on a given day during a two-week cycle. The VEW works primarily with 8 to 10 contact farmers selected within each group. Extension messages are kept simple, concentrating initially on the most important crops in the locality and the most important aspects of crop cultivation at that time. Emphasis is placed on improving cultural practices. At a later stage, use of inputs and more sophisticated cropping systems may be emphasized. The VEW is supervised in the field by AEOs, each supervising about 8 VEWs. VEWs receive the extension message for the fortnight at training sessions held on a fixed day in each fortnight by SMSs. Training and visits take nine days per fortnight. The three other working days in the period are devoted to field trials, making up missed visits, and performing occasional office work.

Technical Support and Supervision

6. This general pattern calls for staff at the sub-divisional and district levels strong enough to ensure satisfactory supervision, training and guidance. Sub-divisional level staff include a sub-divisional agricultural officer (SDAO) with an assistant SDAO (ASDAO) in large sub-divisions so as to keep a ratio of about 6 to 8 AEOs per supervisor. To strengthen technical support and training, a team of SMSs at sub-divisional level is provided, initially one each in agronomy, plant protection and training. At the district level, a district agricultural officer (DAO) supervises the work of sub-divisional staff, while specialists provide additional technical support in such specialties as water management, farm implements, entomology and horticulture. SMSs divide their time equally between field visits (including support for lower level staff), research (including field trials), and training.

Status of Extension in Participating States

7. In all the participating states, a T&V system of extension is in operation and all the sub-projects are covered by Bank-assisted extension projects. In Tamil Nadu, the project is financed under Cr. 1137-IN effective from July 1981 and closing June 1986. The second supportive phase of the project may be covered under NAEP-IV. An overall VEW farm family ratio of 1:1000 is maintained. A contingency provision exists for 300 as necessary, although GOTN so far has not felt the need to invoke this. Six to eight VEWs are supervised by a deputy agricultural officer. The sub-division is under the charge of DAO, who supervises 6-10 deputies. A Joint Director Agriculture oversees all the activities of the Agriculture Department at the district level and he is assisted by a deputy director extension and a team of three SMSs. The DAO also is assisted by three SMSs, one each in Agronomy, Plant Protection and Training/Communications. The Tamil Nadu Extension Project is being implemented satisfactorily. Field visits and trainings are conducted regularly. Research support to extension has been effective. The project has no major problems. The performance of middle level managers needs some attention, and improved training and research support to boost crop water management extension is necessary. GOTN is addressing these issues. The staff position is satisfactory, with most extension workers in position.
8. Karnataka completed the first phase of a reorganized agricultural extension service under the Bank-assisted Composite Extension Project, (Cr. 862-IN (1979-1984). A second phase project, providing further support, is in operation under the National Agriculture Extension Project II, Cr. 1569-IN, effective July 1985. This project will close in June 1990. The PCR indicates that agricultural extension activities under the reorganized management system was well established under the first phase. Field visits have been effective in passing on relevant production know-how. Research extension linkages through monthly workshops have increased the knowledge and skills of SMSs. Joint field visits by scientists have helped in identifying production constraints. Farmers have appreciated the role played by the extension service in command area pilot projects such as the Upper Krishna Project. However, under NAEP-II, the second phase project has encountered problems, including inadequate budget support to ongoing activities which has affected mobility of extension workers particularly, and the transfer of 2,000 field staff to the Rural Development Department following a court action, which has led to staff shortages. At the district level, management techniques for establishing goals and priorities were found to be ad hoc and need support. Another area that needs attention is minimizing the turnover of SMSs and identification of persons specialized in specific fields. The agriculture assistant (AA) family ratio is, in principle, 1:400-800. Seven to eight AAs would be supervised by an assistant agriculture officer (AAO). The district is divided into Talukas (sub-divisions) headed by an ADA. For every three talukas, one cluster taluka is identified and a team of three SMSs are provided. These SMSs operate in all the three talukas. There are teams of four SMSs in every district. The district is headed by a principal agriculture officer. Under the NAEP-II, more SMSs positions have been provided at the district level. One such SMS would be a soil and water management SMS, and another for farm implements wherever necessary. All the NAEP projects support training as a priority sector and include all categories of training from induction training/orientation to SMS upgradation courses. Field study tours have also been include. All the NWMP sub-projects fall within an area where extension is well organized.

9. Andhra Pradesh Agriculture Extension Project, financed under Cr. 1219-IN effective from June 1982, is coming to a close in March 1988. Continued support to strengthen the service would come under the NAEP-IV. The project had to pass through critical periods since the transfer of extension staff from the Rural Development and Command Area Development Departments to the Department of Agriculture was not implemented. Now that this problem has been resolved, it is anticipated that the project will progress to establish the system throughout the state. The command areas are, as of today, well staffed and staffing would not be a major impediment. Research/extension coordination is cordial and monthly workshops and joint field visits are done regularly.

10. In addition to the extension service operated by the DOA, in each of the participation states the SAU has a Department of Extension with activities in all the agro-climatic zones. Its main functions are to:
(a) assist with the technology transfer of SAUs to the extension service at the monthly workshops;

(b) prepare extension brochures and leaflets; and

(c) develop new methods of technology transfer.

Role of Agriculture Extension in Command Areas

11. Agriculture extension services operate in irrigated command areas in basically the same way as in other areas. They are single-function, single line-of-command, technical services responsible for providing farmers directly with technical advice on how to increase their agricultural production and incomes, and for ensuring feedback from farmers to research and other agricultural support services.

12. The role of the agricultural extension service in improving the water management of irrigation systems is crucial. A well-organized extension service (following the T&V system) provides the framework for information flows between farmers, farmer groups and the key agencies involved. As the timing and value of water delivery above the outlet improves through better water management by the Irrigation Department, so would farmers' utilization of the additional and reliable water supply. Thus, extension assists the farmers in better utilization of existing technology and assures feedback to the research stations on technology constraints identified through regular and close contact with farmers. Extension also has a role in monitoring the response of supply agencies to increased demand of farmers for improved services. Extension provides a structure through the already established and operating routines of fortnightly training and monthly workshops, for regular feedback to Irrigation Departments, CADAs and other development and input supply organizations.

13. The command areas represent one or more farming situations within an agro-ecological zone. In the context of this zonal concept, the main responsibilities of the agricultural extension service in irrigated command areas are to:

(a) develop through on-farm research, jointly with staff of the zonal agricultural research stations, appropriate production recommendations, especially for irrigated agriculture, and transfer these recommendations to the farmers;

(b) train farmers, in the course of field visits, in general improved practices for irrigated agriculture;

(c) advise input supply agencies of the current and future input demands and the required supply situation;

(d) assist the ID in the formation of farmer/outlet groups; and

(e) perform all the usual extension functions (e.g., regular field visits and provide feedback to research and agricultural support services on field conditions and farmers' reactions to production recommendations).
Situation and Status of SMSs in Crop Water Management and Farm Implements

14. One of the weakest links in the potential for improving the water delivery system is the low efficiency with which most water is applied and used on the farm. Most VEWs, AOs and higher level extension personnel are not acquainted with improved field techniques for on-farm water distribution, application and field drainage, nor with the farm implements required to apply these improved techniques.

15. Training facilities exist in Tamil Nadu (Water Technology Center TNAU, Madurai) and Karnataka (Training Institute for Minor Irrigation, UAS, at Dharwar). Specialized training facilities for SMSs at WALAMTARI, Andhra Pradesh have yet to become operational. In addition to formal training, SMSs require a practical hands-on training which could best be started in the first batch of sub-projects to be implemented under the NWMP. To that effect, the SAU involved will start small training and screening farms in each scheme, and an operational research program (in which the new SMS would actively participate) in crop water management will be started to generate improved on-farm irrigation agronomy technology (Annex 9). In States where experienced staff for training SMSs and scientists in on-farm water management is insufficient, consultants made available under NARP or by bilateral assistance would be used by the SAUs.

16. Foremost amongst extension objectives in new projects would be to assist farmers in using water when first received (often on sloping erodible land) instead of waiting for full landshaping by the State Land Development Corporation (which is clearly impractical). This problem has been tackled in the Upper Krishna Scheme by CADA/DOA staff, demonstrating on farmers' fields simple farm layouts for irrigation using existing slopes and methods of irrigation for different crops developed by UAS. A large number of simple demonstration plots on farmers land (including introduction of crops new to the area) have been established. This has been done separately from the normal T&V system, which works independently throughout the command area. This type of irrigation development work is badly needed in both new and existing commands, since the additional workload cannot yet be effectively done by the normal extension staff. However, when SMSs in water management become available, VEWs and AOs in command areas should be trained during special, as well as regular fortnightly, training seminars, particularly in the practical skills required to survey a farm and mark out the required field irrigation layout.

Contact With Other Agencies

17. Based on the annually projected and adjusted cropping pattern, estimates of required farm inputs should be prepared following the research recommendations for that particular farming situation. Estimated input requirements would be brought to the attention of the public and private input suppliers and credit organizations, advising them also on the expected timing of farm operations with the new water management plan and subsequent timing of input deliveries.
18. The extension service also has an important role in advising the ID or CADA on the identification and establishment of farmers' groups, since they are far more intimately and directly involved with farmers and villages than ID so far.

19. Feedback to research on farmers' needs would be achieved through: (a) the monthly workshops; (b) joint diagnostic visits made with SAU scientists in connection with Status Report preparation and update; (c) evaluation of farm trials by the SAU scientists; (d) joint surveys with SAU scientists (including SMSs) of the most important crops 3 or 4 times during the crop season (just after sowing, during mid-season and near harvest) to observe production trends, weather effects and incidence of pest and diseases; and (e) diagnostic analysis of selected distributories of minors.

Extension Organization and Staffing in Command Areas

20. Operational adjustments in normal extension activities are required to enhance their effectiveness in irrigated command areas. Some of these adjustments could be:

(a) Delineation of VEW Circles. VEW circles, and farmers' groups within these, would be delineated so that they (entire circles or some farmers' groups within circles) include, to the extent possible, either irrigated or non-irrigated fields/farmers. Extension operations are easier to implement if most farmers in a circle or group have either irrigated or un-irrigated fields. Most farmers, however, have both irrigated and non-irrigated land and so a rigid delineation is difficult to attain. Farmers' groups in command areas would, wherever feasible, coincide with a set of irrigation outlets, which may be different laterals, but which should form a contiguous area. In delineating circles and groups, allowance would be made for areas likely to be irrigated in the near future.

(b) Delineation of AEO Ranges. AEO ranges would be delineated, where feasible, in such a way that an AEO would be responsible for VEWs who are working either in predominantly irrigated or non-irrigated areas. However, the basic principle of contiguous VEW circles and a contiguous area under the charge of an AEO should be followed. The AEO would ensure that all major crops and production systems of all farmers in his range are adequately served by the extension service.

(c) Intensity of Field Staff Coverage. The intensity of coverage by extension field staff (VEW, AEO) in NWMP sub-projects should be increased until the operational changes in water management, cropping patterns and improved on-farm irrigation techniques, have been well established and adopted. Due attention would be given, however, to other relevant factors, such as the uniformity of production systems and practices, ease of communication and settlement density. Consideration may also be given to double the frequency of the VEW visit to each farmers' group to once in seven days rather than once in two weeks (spending a half-day with each of the eight farmers' groups in his circle) during the first two years of the project; frequency of visits would depend, inter alia, on cropping activities and the water management system.
(d) **Specialized Technical Support.** Subject Matter Specialists (SMSs) in irrigation agronomy and/or water management, and in specialized crops grown in command areas (as well as SMSs in other basic subjects), are likely to be required at each operational level (sub-division, district and head-quarters). In major command areas, consideration may be given to having a Joint Director of Agriculture responsible only for overseeing extension and other Department of Agriculture activities in the command area as a whole. At Department of Agriculture headquarters, there would be a senior DOA officer with overall responsibility for coordinating the Department's input into irrigation planning, liaising with the Irrigation Department's O&M Cells and/or CADA, and providing technical guidance to SMSs in irrigated areas. He could be seconded to the ID O&M Cell as has been done in Karnataka.

(e) **Contact Farmers.** The number of contact farmers in each farmers' group which covers an entirely, or mostly, irrigated area would be increased to about 15 in view of the usual compactness of the area. Leaders of outlet groups would be included among the contact farmers.

**Progress in Support of NWMP**

21. No special extension programs in NWMP sub-project areas have so far been initiated in any of the three participating States. Extension programs to support NWMP would consist of:

(a) Delineation of AEO and VEW circles as outlined above;

(b) Development of a training program for water management SMSS with the SAUs as indicated in Annex 9, and the programming of the number of trainees according to the implementation schedule of NWMP. The target density would be one SMS per sub-division and the high turnover of SMSs (not longer than 3 years in a certain position) should be taken into account when determining the annual number of trainees;

(c) Operational research and on-farm research as envisaged in Annex 9 would involve the SMSs more closely with research and the generation of technology and hence provide more professional stimulus. A good SMS could be taken on by the SAUs as junior scientists in irrigation agronomy; and

(d) In order to plan and implement these support and training programs, the appointment of special JDAs in command areas and a senior DOA official in the O&M Cell as recommended in para 3.16(d) should be ensured as part of the state's commitment to NWMP.
GENERAL

1. The proposed NWMP aims to strengthen the capacity of the State Government institutions to plan, implement and evaluate improved irrigation management practices. The emphasis is on the preparation of an operational plan for water delivery, and therefore on the role of the Irrigation Department. Nevertheless, the role of the Agricultural Agencies is crucial, both in the preparation of the operational plan and during implementation. Linkages between the Extension and Research agencies are an integral component of the T&V system of agricultural extension (Annex 9). This Annex briefly reviews how similar linkages will be established between these agricultural agencies and the Irrigation Departments.

PREPARATION AND APPROVAL OF NWMP SUB-PROJECTS

2. Primary responsibility for the preparation of NWMP sub-projects will lie with the Project Preparation Cells (PPCs) within the respective Irrigation Departments. Agricultural staff, on secondment to the PPCs from the Departments of Agriculture, will participate in this process and be responsible for the agricultural planning aspects of sub-project preparation. For each scheme, the process will involve diagnostic analysis of scheme performance in association with local irrigation and agricultural staff, and in consultation with the farmers (Annex 4). The seconded staff will be responsible for ensuring that the local agricultural extension staff are fully involved in this process, and that the local research establishment are fully consulted, and that available research results are reflected in the operational plan proposed. Where necessary, they will initiate additional resource surveys and data collection by the appropriate agencies (e.g. soil surveys, groundwater mapping and assessment, cropping pattern and yield data, agro-economic surveys, etc) and will ensure that these are completed as a basis for sub-project preparation. They will contribute to establishing the agricultural objectives of the operational plan, and ensure that the water distribution techniques adopted adequately serve the requirements of the cropping plan. Together with the local extension and other staff, they will ensure that the proposals are fully discussed with the farmers and that farmer response is reflected in the proposals submitted.

3. Primary responsibility for clearance and approval of NWMP sub-projects will rest with the State Government concerned. A committee or committees will be established at the State level for this purpose (Annex 8).
on which both the Department of Agriculture and the SAU will be represented. Following State clearance, the sub-project proposal will be submitted to the NWMP Appraisal Committee in the GOI Ministry of Water Resources to ensure that it follows the guidelines established for the project. The GOI Ministry of Agriculture and ICAR will be represented on the Appraisal Committee.

4. Implementation of the NWMP scheme investments will be primarily the responsibility of the Irrigation Department. Progress will be monitored by the PPC which will submit regular progress reports to GOI and IDA. Given ongoing agricultural extension (Annex 9) and agricultural research (Annex 10) programs supported by the Bank, no additional provision is made under the NWMP for these supporting services. As discussed in the earlier annexes, however, within the framework of these other programs, measures would be taken to ensure they respond to the requirements of the NWMP.

Operational Decision-Making

5. State Level. At the State level, there exist a number of mechanisms for ensuring coordination between irrigation and agricultural agencies on irrigation matters. These include the Irrigation Coordinating Committee or similar, usually chaired by the Agricultural Production Commissioner, and comprising the Secretaries of Irrigation, Agriculture, Cooperatives, the Vice Chancellor of the SAU, and other members. This high level committee makes recommendations to the State Government concerned on all matters relating to the construction and operation of irrigation projects. 1/ Within the framework of the administration of CAD activities, there is also in some cases a State level body (e.g. the CAD Board in Andhra Pradesh) which reviews Command Area Development and operational proposals for all schemes included under the program in the State. In other cases, the Working Committee (as in Andhra Pradesh) or the CAD Board (as in Karnataka) for individual schemes may include State level representation.

6. District Level. The District Irrigation Committee (in Tamil Nadu) or Irrigation Development Board (in Andhra Pradesh) is chaired by the District Collector and has both official and non-official (including MLAs, farmer representatives, etc) membership. It reviews all irrigation matters in the district. While in the past this has included operational matters relating to major schemes in the District, this has not always proved an effective mechanism for taking scheme-level decisions. Not only may a scheme fall in more than one district, but involvement of representatives from throughout the district may prevent an adequate focus being given to the requirements of a specific scheme. Under the project, therefore, scheme-level committees will be established (as in Karnataka) for all NWMP sub-projects.

7. Scheme Level. In Karnataka, an Irrigation Consultative Committee, with both official and farmer representation, has decision-making responsibility for system operations. In Andhra Pradesh, similar seasonal "workshops" are held in the command area for those schemes coming under the CAD program, although their recommendations are subject to the final decision

1/ Comparable State and Zonal Committees have been established under the...
of the state-level CAD Board and its Working Committees. Under the project, a scheme-level committee will be established for all NWMP sub-projects. Within the framework of basin-wide water allocations, this committee will have responsibility for system operations. It will meet prior to each irrigation season to approve the operational plan, and define the rules for its implementation, and after each season to evaluate experience gained.

Interaction Between Irrigation and Agricultural Agencies at the Scheme Level

8. The scheme committee will be the primary decision-making body for operational matters and will provide a framework within which irrigation and agricultural officials can coordinate their activities, both with each other and with the farmers. Nevertheless, there will be a need for additional technical interaction both at the planning stage for a season's operations and during implementation of the seasonal plan.

9. At the Seasonal Planning Stage. Full objective discussion of the technical issues will be difficult at the pre-seasonal scheme committee meeting, given the pressures from differing interests and the role of the Committee as a management decision-making body. Discussions between irrigation and agricultural staff will therefore be needed prior to the seasonal meetings to evolve a coordinated set of technical recommendations to be submitted to the Scheme Committee. Within the framework of the approved operational plan for the scheme, these recommendations would cover such factors as reservoir operations, canal opening and closing dates, and irrigation schedules, inter alia taking into account climatic conditions, water availability and the evolving cropping pattern. Based on the recommended seasonal plan, the irrigation and agricultural officers would schedule their staffing and other activities, and following approval of the proposed plan, modified if necessary, the input supply agencies (both private and public) would be advised of complementary input requirements (e.g. for seeds, fertilizers, pesticides, credit, etc) and farmers informed of what to expect.

10. During Implementation. The T&V extension system provides an appropriate framework for regular interaction with the Irrigation Departments and other input supply agencies. Monthly workshops at the district level provide a forum for senior officials to review seasonal production constraints, update production recommendations and modify operational plans and procedures. Although these are not held on a command area basis, the fact that they are already established argues in their favour as a regular meeting ground. Similarly, the fortnightly training sessions for VEWs provide an appropriate forum for interaction at a lower level. It will not be necessary for ID (or other input supply) staff to attend the full session but:

(a) at the monthly workshop, the ARE/EE concerned would brief the extension and research officers regarding the programmed distribution of water and take note of any special requirements, farmer reactions and cropping developments; and

(ii) at the fortnightly training session, the AE concerned would brief the VEWs on the schedules for the coming period and on O&M requirements of the sub-command concerned, and would in return be advised regarding any problems faced by the farmers.
The effectiveness of these arrangements would be increased to the extent that AO and VEW circles can be reorganized for predominantly irrigated areas and can be adjusted on a distributary/minor/outlet basis. In addition to participation at the regular monthly and fortnightly sessions, it would be desirable for ID and Agricultural staff to make joint field visits to discuss matters of mutual interest and to get firsthand experience of farmers reactions and problems.

11. The virtue of ID involvement in the regular T&V mechanisms would not be confined to improved coordination between irrigation and agricultural staff. Through their regular field visits, the VEWs can provide a channel for the wide dissemination of information to the farmers and, similarly, a mechanism for feeding farmer reactions back up the system.

A Possible Management System for ID Staff

12. The T&V system provides for a regular system of interaction up-and-down the agricultural extension hierarchy and between the extension service and the farmers. While a system as intensive as this is not required for ID staff, there are strong arguments in favour of regular meetings between officer level and grassroot level ID staff, and between the latter and farmer representatives. A regular system of meetings among ID staff could do much to improve communications within the department and help ensure all staff work with a common purpose. As under the T&V system of extension, such meetings could be combined with a regular training program (Annex 14). The extent to which regular meetings (visits) between ID staff and farmers can be established will probably be a function of the pace at which farmer organizations are established (Annex 12). Nevertheless, even if regular visit schedules are a long way off, this does not negate the principle that the AE, Works Inspector and Laskar should be in direct contact with the farmers, and that there should be regular interaction between those responsible for water delivery and the users.
IN INDIA

NATIONAL WATER MANAGEMENT PROJECT

Farmer Involvement

General

1. Experience has shown that it is not usually possible to provide individualized service to individual farmers and plots with the infrastructure available in surface irrigation projects in India. Consequently, at some level in the system, control must be transferred to the farmers. However, farmers cannot be expected to organize themselves effectively to perform their role if the supplies they receive are unreliable. Thus, the first step in ensuring effective farmer participation is to frame an operational plan that is realistic in terms of the available infrastructure. Once this is done, and the plan has proved generally acceptable to the farmers, consideration needs to be given to the form of such participation. Some form of cooperation universally exists and informal organizations have been set up in many schemes. These concentrate on water distribution and maintenance below the Government outlet, but in some cases they have a broader role (e.g. those in the tail end reaches of the Rajolibunda Diversion Scheme in Andhra Pradesh, see Annex 5), and it is possible to envisage their full integration in the management of the scheme (e.g. through elected representatives on the scheme committee). The speed with which this can be achieved will vary from scheme to scheme and will in part depend on the effectiveness of the operational plan. No single approach or structure will be appropriate for all situations, but within the context of the NWMP water user associations will be promoted which build on existing forms of organization, follow hydrological boundaries (outlet/minor/distributary), and focus on irrigation management and system maintenance, initially in the minor system but ultimately throughout the scheme.

Farmer Participation in Evolving an Operational Plan

2. In preparing operational plans, and selecting interventions for inclusion under the NWMP, it is essential to understand and take into account farmer needs and aspirations. Thus:

(a) all aspects of cropping developments in the command need to be studied, taking into account how socio-economic conditions have evolved over time; and

(b) a clear understanding needs to be reached as to how farmers are likely to respond to changes in system operations and management.
3. Ways in which such an understanding of the farmers' position can be obtained will vary. Farmers or their representatives can be consulted formally (e.g. through an hierarchy of farmer committees) or informally (e.g. through calling farmer meetings, field visits by the preparation team, etc). Alternatively, formal surveys can be undertaken to establish initial baseline conditions and to monitor evolving farmer conditions and responses to management changes. The guidelines set out in Annex 4 suggest an approach to the diagnostic analysis of scheme problems which could use any or all of such techniques.

4. Once an operational plan has been formulated, it is important to obtain farmer concurrence so that they are committed to what is proposed and are fully aware of what to expect. How such concurrence is to be obtained in relation to an NWMP sub-project proposal has been left to the discretion of the State Government concerned (Annex 8) since a formal approval mechanism might lead to unresolvable local conflicts (e.g. between headenders and tailenders). In some instances, a complex series of district and local discussions may be necessary, leading to formal agreement to revise the system operation rules (as has occurred for the Sathanur scheme in Tamil Nadu). In other cases, informal discussions leading to modification of previous practice on a season-by-season basis may be all that is required.

5. Once the NWMP sub-project proposal has been cleared and approved by the GOI Appraisal Committee, the Scheme Committee, on which farmers are represented, will decide how the revised operating rules are to be applied in each irrigation season. Similarly, the Scheme Committee will evaluate the season's outcome as a basis for further modification and refinement, while the ID, in cooperation with the farmers, will be responsible for implementation of the scheme investments.

6. In addition to obtaining Scheme Committee approval for a seasonal operational plan, mechanisms will be required to ensure that farmers are fully aware and informed in terms of what they are to expect. If they do not know what their rights are, or what water they can expect, then they have no basis on which to respond to the operational plan. Information can be passed through the extension service, through formal or informal farmer meetings, or through the media (radio, newspapers, pamphlets, notices, etc). All these mechanisms should be used to create widespread awareness of the water delivery plan, ensure that farmers respond to the opportunities created, and enable input supply agencies to prepare for its requirements.
Experience with Farmer Organizations

7. Existing forms of cooperation between farmers include informal arrangements for distributing water and maintaining field channels, joint employment by neighbouring farmers of a common irrigator to manage water (especially for paddy), 1/ and more formal arrangements based on village or distributary organizations (for instance in the tail reaches of the RDS in Andhra Pradesh where up to 300 farmers covering perhaps 1,000-1,500 ha combine to regulate the allocation of the uncertain supplies received). 2/ Government sponsored organizations have also been promoted, especially in the context of the GOI centrally-sponsored 'warabundi' program, under which CADA staff (in Tamil Nadu, AED staff – see Annex 8) organize an outlet committee in cooperation with the farmers, and establish a rotational schedule (often detailed on a board at the head of the field channel) for distribution of water by time between the participating farmers. Up to Rs.350 per ha is spent on ancillary facilities, including construction of a measuring flume, distribution boxes, marginal realignments and improvements, the 'warabundi' board, etc, with this financed by a GOI grant. Under the Andhra Pradesh Irrigation Utilization and CAD Act (1984), a legal framework has been established for forming these committees, but legal registration has rarely, if ever, been invoked, and such committees in all three States have generally been informal, even if 'officially' sponsored.

8. Experience has shown that organizations sponsored by CADA and AED have rarely outlasted the active involvement of CADA/AED staff, 3/ in particular if supplies are uncertain and the detailed time schedules prepared are almost invariably ignored. In contrast, those forms of organization and

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1/ The common irrigator can become very adept at adjusting flows to local topography, soil characteristics and crop needs and typically cooperates well with neighbouring common irrigators so long as flows are adequate. In the event of reduced supplies, this cooperation increasingly breaks down and those at the head pre-empt supplies to safeguard their crop and those at the tail suffer.

2/ A register is maintained whereby individual farmers receive water, whenever it is received, in strict rotation, the frequency and timing of each farmer's turn being a reflection of the pattern of supply during the season in the distributary/minor. This is similar to the 'osra-bundi' system of UP (which should be distinguished from the 'warabundi' system of NW India under which security is assured to a certain level, and farmers have their turn at a specified time of the week if the minor is running at that time.

3/ A well-documented case is Sriramsagar (Pochampad) in Andhra Pradesh where a pilot program in the late 1970s/early 1980s, focussing on farmer organizations and rotation below the outlet, initially had an impressive impact on production (see GOAP/FAO IBRD CP: "Andhra Pradesh Rotational Water Distribution Project," Draft Preparation Report, Annex 1, 1981). However, not only was it concentrated in areas with secure supplies to the Government outlet, but, when the leadership behind its original
cooperation which have evolved voluntarily out of a 'felt need' by the farmers concerned are usually permanent. This is particularly the case in paddy areas, given the extreme sensitivity of paddy to water stress, but examples also exist (e.g. in RDS) where farmer organizations have arisen in response to uncertain supplies, primarily for ID crops. The latter in particular imply that there is considerable potential for developing more extensive water user associations, but also suggest that they should not be forced by outsiders according to a rigid pre-ordained blueprint (as has occurred under the 'warabundi' program), but should evolve in response to farmer needs, preferably building on forms of organization that already exist. Clearly, the need for local leadership is paramount, and only if such organizations serve a purpose recognized by the participating farmers will they be maintained.

A Possible Future Structure

9. Subject to the above reservations, water user associations will be promoted in the context of the NWMP to assume responsibility for O&M below the Government outlet and to participate increasingly in the management of the scheme as a whole. Logic, as well as practical evidence (not only from India), suggests such associations should be organized along hydrological boundaries: should concentrate on irrigation management issues (and should not evolve, at least initially, into multi-purpose institutions); and should establish direct contacts with ID staff (at the outlet level with the Laskar, at the minor/distributary level, if committees at these levels are created with the AE). All farmers served by the irrigation system would belong to a water user association, and an hierarchy of representative committees might be built up as follows (the number of levels in the hierarchy depending on the size and complexity of the system):

(a) Outlet Committees

Each outlet having 15-20 farmers might form an outlet association (if there are more than 15-20 farmers, additional groups might be formed, contiguity of area being maintained in forming such groups). Each outlet association would elect a committee of 3-5 members and a chairman who would become a member of the minor/distributary committee. Functions of the outlet committee would include: distribution of water as per the scheduled rotational water supply; maintenance of field channels and field drainage channels; prevention of unauthorized use of water; modification of rotations within the chak if necessary; and redressal of grievances of farmers within the chak. All aspects of irrigation management that concern farmers in the chak would be the general concern of this committee.

(b) Minor/Distributary/Branch Committees

The chairmen of all outlet committees on a minor/distributary would form a minor/distributary committee and among them in turn elect a chairman. Functions of the minor/distributary committee would be to help resolve problems that arise between outlet associations; ensure the outlet committees are functioning; liaise closely with ID/CADA staff; and, in association with ID staff, distribute water equitably between outlets and farmers in the event of unexpected
shortages. Depending on the size and complexity of the system, chairman of the minor/distributary committees might form committees at a higher level in the system and ultimately provide farmer representation at the scheme level committee.

10. As argued above, such organizations are only likely to prove effective if water is distributed according to a realistic and predictable operational plan, and if they reflect farmer needs and perceptions. Subject to these pre-conditions, they would increasingly lead to a situation where farmers participate fully in the management of the system and perhaps ultimately generate a feeling of common ownership of the scheme as a whole, with its concomitant impact on disciplined water use, improved O&M and collective responsibility. 1/

Establishment of Permanent Water User Associations

11. The emphasis should be on voluntary water user associations. Nevertheless, if these organizations are to be established on a permanent basis, some administrative sanctions may be required to make them effective and to ensure that they are not taken over by the rich and powerful. This might include laying down election procedures where the traditional farmers' representation system fails, ensuring representation by small farmers, ensuring representation from the head/middle/tail, defining a quorum, establishing the duties and responsibilities of various officers, etc. The extent to which legal sanctions would be required to enforce such administrative arrangements, and to regulate abuses, would have to be carefully considered. Too much regulation and control by government agencies, particularly for existing associations, should be avoided.

12. The promotion of water user associations would need to be followed by changes in the responsibilities, attitudes, and perhaps organization of government agencies. The ID/CAD authorities should have primary responsibility for promoting such associations (possibly assisted by extension officers). If the Extension Service is also organized on an outlet basis, then linkages between systems operations and agricultural research and extension would be much easier to establish. In matters relating to systems operations and water distribution, the associations/committees would cooperate directly with the systems operators (ID/CADA), and the laskar will, in particular, have to provide the appropriate cooperative link between the farmers and the operating agency. In matters relating to on-farm irrigation practices, the associations/committees would, over a period, provide an effective framework for extension advice to individual farmers, with committee members possibly acting as contact farmers under the T&W system. As extension officers gain a better understanding of the way the system operates, the extension advice provided would improve and the lessons learnt from field applications could be fed back through the extension service into the

1/ The role of water user associations in O&M, and the effect this might have on O&M activities and funding by the State Government, will be assessed in the context of the proposed O&M reviews in each State (see
research and planning process, leading in turn, if necessary, to revisions of
the operational plan.

Training Needs

13. Functionaries of the various committees should be trained to enable
them to perform their responsibilities and exercise their rights. They
should be instructed how to conduct meetings, record minutes and operate an
information system. They should be aware of the role of other departments
(Agriculture, Revenue, input agencies) in irrigation water distribution and
crop production. The training opportunities provided by the Agriculture
Department under the extension services should support the efforts of the ID
(See Annex 14).
1. The Monitoring and Evaluation (M&E) program to be implemented under the NWMP will have three main functions:

(a) To monitor physical and financial progress of NWMP components as a basis for reporting to Government and the Bank. This will be done by PPC staff (with assistance from scheme based staff) for as long as the project is under implementation.

(b) To monitor operations and maintenance at the scheme level. This will have three elements:

(i) An internal information system to monitor operation on a day-to-day basis. The use to which the data is put will depend on the current operational plan. For most schemes, two distinct operation modes have been identified.

- A demand mode in the kharif based on response to rainfall and pulsed into the system blocks in discrete doses

- A pre-scheduled mode in the rabi, again pulsed into the system blocks in quantas.

The first mode requires a real time decision capability to switch the block on or off, and for this immediate feedback data is necessary. The operational block, the criteria for switching and the responsibility level for making the operational decisions will have been specified in detail in the operational plan.

The second mode normally requires no real time decisions and the monitoring function is to make sure that, while running, the system is not grossly in default (due to breaches or interference) and to provide a basis for post season analysis of performance.

(ii) A seasonal/annual reporting system to the Scheme Committee based on data gathered in (i) above, to record how closely the operational plan was followed, present information on water use, irrigated areas and production, and evaluate the season's outcome; and
(iii) a seasonal/annual reporting system to monitor departmental activities for maintenance.

These will be the responsibility of scheme level staff, with technical guidance from the State level O&M Cells. 1/

(c) To evaluate the impact of the operational interventions supported under the project on an independent and in-depth basis. This will be the responsibility of staff of the State O&M Cell 1/ with specified studies sub-contracted as required to independent research institutes, Government agencies or private consultants.

2. Whereas the NWNP monitoring program ((a) above) will last only as long as the project, the other two elements will develop into a permanent information and reporting system designed to deliver information in ways which increase the effectiveness of irrigation management. The distinction between "monitoring" by scheme staff ((b) above) and "evaluation" by independent agencies ((c) above) is in practice far from clear-cut since these two activities are two ends of a continuum, with the information generated by the monitoring program feeding directly into the evaluation process. Care will be needed in all cases to confine data collection, monitoring and reporting to that which can be used effectively and to avoid overloading scheme and State staff with unnecessary activities.

Monitoring of the NWMP

3. The monitoring of NWMP components will be undertaken by the PPC and scheme ID staff so as to provide GOI and the World Bank with the information required for normal project supervision.

4. For each sub-project, an implementation program will be prepared based on the approved designs and estimates and in advance of any expenditures. Thereafter, progress reports will be prepared half-yearly (for semesters to end-September and end-March respectively) 2/ presenting physical and financial progress on the following:

(a) surveys and investigations;
(b) scheme investments (including roads and buildings);
(c) procurement of vehicles and equipment;
(d) O&M activities (including staffing); and
(e) training programs.

1/ Although in the long term these activities will be the responsibility of the State O&M Cells, in the earlier years they may be undertaken by the PPCs (see Annex 8).

2/ The report to end-September will provide information on progress achieved during the previous construction season (usually to end-June or thereabouts) and provide a basis for establishing an implementation program.
5. Draft reporting formats will be developed to be supported by brief explanatory notes. Report preparation will be the responsibility of the ID officer in charge (Superintending or Executive Engineer). Reports will be submitted to the appropriate officer in the PPC to be summarized and collated in a State Report. The State Report will also present information on State level progress and components, budget allocations and expenditures, "Compliance with Credit Covenants", "Compliance with the Recommendations of Previous World Bank Review Missions", reimbursement applications and disbursements and perhaps other matters.

Monitoring Operations at the Scheme Level

A. Data Collection and System Control: Operations

6. A data collection and management information system will be established at the scheme level to record basic data and provide the scheme management with the information necessary to implement the approved operational plan and to make operational decision that may prove necessary (para 1(b)).

7. Before each season a detailed water budget will be drawn up specifying the water to be allocated to each distributary command or group of distributaries. The period for which water will be budgeted will be either an irrigation issue (where this is clearly specified, for instance for intermittent schedules) or a week or fortnight (for instance for continuous supply). The implied water requirement at the heads of the branch and main canals should also be presented, together with the water loss assumptions.

8. The internal information system will cover the following:

(a) Rainfall and climate. The ID staff would:

(i) during the scheme preparation review the location of rain gauges and climate stations, to ensure that the command is satisfactorily covered, and relate all parts of the command to a specific climate station;

(ii) check the accuracy of these climate stations; and

1/ It is assumed that a distributary command would normally be an appropriate accounting unit. The level at which water is to be allocated will, however, need to be clearly defined for each scheme, taking into account its characteristics and the practical problems of water distribution and measurement.

2/ The basis for budgeting water by distributary command would be set out in the operational plan. A summary should be prepared, setting out the basic principles, to guide staff in preparing the water budget, and a brief note to accompany the budget should be submitted stating how these
(iii) establish reporting procedures and responsibilities to ensure that the ID officer in charge receives regular reports.

(b) Water availability. The ID staff would:

(i) establish appropriate gauge recorders for river inflows, reservoir storages, etc. and check their accuracy on a regular basis; and

(ii) establish procedures and responsibilities for recording water availability/storage at appropriate intervals.

(c) Crop establishment and harvesting. For paddy this should cover establishment of nurseries, puddling/transplanting, and harvesting. For other crops it should cover sowing and harvesting. All estimates should be presented on a distributary command or group of distributaries basis, depending on the accounting unit for the water budget. The ID staff would:

(i) establish procedures for recording these area statistics to an acceptable level of accuracy; and

(ii) establish reporting procedures and responsibilities so that the ID officer in charge receives regular reports.

(d) Water Deliveries. These should be presented on the same basis as for the water budget. The ID staff would:

(i) establish appropriate measuring devices throughout the distribution system to allow spot checks on system performance;

(ii) check the accuracy of these devices on a regular basis;

(iii) establish procedures and responsibilities for recording discharges at appropriate intervals; and

(iv) establish procedures and responsibilities for calculating total water deliveries.

9. In most cases, adequate data collection procedures will already be in place in which case they should be described and utilized, if necessary modified to accord with the requirements set out above. During the course of project implementation, computer-based data handling and retrieval systems will be introduced, initially in the larger systems but subsequently more widely.

B. Seasonal/Annual Reporting: Operations and Agriculture

10. A seasonal/annual reporting system will be established to provide the scheme committee with an assessment of how closely the operational plan was followed, evaluate its impact on cropped areas and agricultural production and, if appropriate, suggest modifications for subsequent seasons/years. Taking this report into account, the scheme committee will decide on the operational plan for the following year. Draft reporting formats will be...
(a) Rainfall and climate (by climate station);
(b) Water receipts and availability;
(c) Reservoir operations (working tables);
(d) Water deliveries (by sub-command);
(e) The timing of crop activities (by sub-command);
(f) Irrigated areas by major crops (by sub-command); and
(g) Crop yields and production.

11. With the exception of crop yields and production, these summary
    presentations will be derived from the data collection and retrieval system
    established by the Irrigation Department (see above). Arrangements would be
    made with the appropriate agricultural agency (CADA, AD, etc) to provide
    regular and reliable crop yield estimates. In addition, irrigated and crop
    area estimates made by the Irrigation Department may be compared and corre-
    lated with those derived from other sources (Agriculture, Revenue, etc). 1/

12. The operational plan initially approved will establish the basis for
    evaluating operational performance. The extent to which it was adhered to,
    and the reasons for any deviations, will be described and assessed (e.g.
    reservoir operations, opening and closing dates, irrigation schedules, water
    deliveries, etc).

C. Departmental O&M Activities

13. A management information and reporting system will be established
    covering Departmental activities. Among aspects to be covered would be:

    (a) Budgetary allocations and expenditures;
    (b) Staffing and related matters;
    (c) Scheme investment programs (e.g. NWMP works, OFD works, other works;
    (d) Maintenance activities and programs;
    (e) Buildings, vehicles and equipment;
    (f) Measurement and data collection programs;

1/ In the longer term the coverage of the seasonal/annual report on opera-
    tions may be broadened to include such activities as seed supply, farm-
    ing aids, etc.
(g) Farmer organizations and meetings; and

(h) Training activities.

14. An appropriate system will need to be developed and reporting formats prepared, taking into account specialist O&M advice. As in the case of operations, establishing an O&M plan would provide the basis for monitoring departmental activities and for evaluating performance and identifying problem areas. There will be some overlap between the reports on operations and those on departmental activities, and consideration will need to be given to how they should be coordinated and prepared.

15. The above refers to an information and reporting system for the ID O&M organization. Comparable systems would be developed for other departments and agencies active in the command area as a basis for monitoring their activities, evaluating their performance and identifying problem areas.

Independent Evaluation Programs

16. The programs outlined above for monitoring operations at the scheme level would be implemented by scheme level ID staff. In addition, funds have been included under the project to undertake independent evaluation and other studies, both in major schemes and, possibly, across schemes and States. Among subjects that could be covered are:

(a) Periodic verification/consistency checks of the assumptions used, and information generated by the implementing agencies. Possible areas to be covered include:

(i) water measurement and recording;

(ii) seepage and operational losses; and

(iii) estimation of irrigated areas.

(b) Evaluation studies of the impact of revised operational interventions on agricultural production and farmer welfare. These could cover:

(i) the impact of the operational interventions on agricultural production and value-added;

(ii) the impact on farmer incomes in relation to location in command size of farm;

(iii) the adequacy of water delivery in relation to evolving cropping patterns and crop water requirements;

(iv) groundwater utilization and its relationship to canal water deliveries;

(v) farmer attitudes to the operational interventions and the performance of water users associations;
(vii) the performance of the line departments in the implementation of the operational plan.

(c) Special studies on problems or issues not covered by routine surveys and studies.

17. The surveys and studies to be undertaken under the independent evaluation program would employ normal sampling techniques designed to establish inferences according to a predetermined level of precision. The aim would be to provide a reporting service which complemented the generation of information through the normal activities of the line departments. Together with the latter, the information collected would be analyzed in terms of its implications for the operational procedures and practices being implemented, and reports, including recommendations for modifying the latter (if appropriate), would be submitted to the scheme authorities, scheme committees and Government.

Administrative Arrangements for M&E

18. The PPC in each State will be responsible for monitoring implementation of the NWMP and for preparing the bi-annual State reports for submission to GOI and the Bank. They will ensure that the scheme staff submit timely information for inclusion in the bi-annual reports.

19. For the larger schemes, a planning, data handling and monitoring unit will be established in the office of the SE *inter alia* to prepare seasonal operational plans, monitor scheme operations and prepare the proposed seasonal/annual reports. These units will establish appropriate links with agricultural and other agencies in the command area. For smaller schemes, the EE or AEE in charge will be directly responsible. The O&M cells at the State level (initially also the PPCs) will help introduce M&E practices at the scheme level, develop reporting formats and procedures, and monitor progress. Until basin-wide organizations are established, they will ensure consistency in the operations of inter-dependent schemes.

20. The O&M Cells (initially also the PPCs) will also commission evaluation and other studies from outside agencies, and will establish links with M&E activities in other State departments, notably the M&E Units in the Agricultural Departments. Based on the reports and information collected from the scheme staff, independent agents and consultants, and other Government M&E units, the O&M cells (initially also the PPCs) will help evolve O&M policies statewide and ensure that information regarding successful and unsuccessful interventions is shared across schemes and basin.
Introduction

1. Improved water management practices would need training of concerned staff both at GOI and State/Scheme level. The GOI level training would essentially consist of widening the existing knowledge in water management practices supported by appropriate study tours. The State level training would be concerned with planning, design, implementation and operational stages of the project. Each stage would require specific skills for which the project would provide the know-how. In addition, orientation training of concerned scheme senior staff and information of farmers on their specific part in the project would be provided. The State/Scheme level training needs could be classified into six levels (refer also to the attached table).

(a) Orientation
(b) Planning
(c) Design
(d) Implementation and Operation (two levels)
   (i) Officers
   (ii) Work inspectors
(e) Farmers

A. GOI Training Level

2. The water management cell of the GOI would receive training on aspects corresponding to their catalyzing role in the NWMP. This would consist of seminar type meetings lasting about 2 weeks. Yearly refresher courses of about 3 days duration would provide for further in-depth training and new recruits as well as reorientation training based on experiences gained during the course of the project. World Bank staff would participate in these seminars as may be appropriate. In addition, appropriate study tours abroad would be financed for four staff members to further broaden their technical skills in water management practices.
B. State/Scheme Level Training

Orientation Training

3. Training for senior officers directly or indirectly involved in the NWMP would be provided. Such training would consist of: (a) information on the project objectives and its approach; (b) an overview of water resources and their best use for optimum crop production and financial returns to farmers; (c) the role and support needed from CADA, the Agriculture Department and other institutions; (d) the importance of monitoring and evaluation; and (e) an overview of policy implications that might arise for other schemes.

4. The officers in question might comprise Deputy Secretaries (Irrigation and Agriculture), Chief Engineers, Superintending Engineers, Directors of Agriculture, CADA Administrators, representatives of financial institutions, etc. The total number of officers to be trained would be about 20 for each State. The orientation training would be done in form of a seminar or workshop similarly to the interstate workshop on Warabundi held in Hyderabad in 1980. Such a workshop would be held for 3 days initially with follow-up workshops yearly for 2 days over the remaining project period. The follow-up workshops would allow experiences gained from various projects to be presented, analyzed and discussed. Statewide and regional policy decisions may result from these exchanges.

5. The orientation training program would be organized by one or other of the State training institutes. Contributions to the workshop would be expected from the Institute's staff, guest speakers and officers familiar with the NWMP approach, and staff from the World Bank.

Training for Planning

6. The PPCs/O&M units 1/ established in each State fulfill an important role in the entire NWMP. To be effective they would need a combined knowledge of most aspects of irrigation sciences, irrigation engineering, agriculture, hydrology and economics. Needless to say, such breadth of experience is difficult to find. The O&M would therefore be a most important target group for training. A number of options can be proposed, some of which may be combined:

(a) Intensive training courses through lectures over 2 months depending upon the background of the trainees;

(b) In-service training by specialists financed under the credit and/or the World Bank;

(c) Study tours to other States and neighboring countries with comparable irrigation management problems; and

1/ Initially PPC staff may be primarily concerned although, in the long
(d) Longer term courses of say 6 months to 1 year, mainly of younger staff, at appropriate institutions or colleges.

7. The final selection of a training program will probably differ between the States depending upon the existing expertise within the PPC/O&M units as well as within the State. For instance, it is possible that Tamil Nadu will opt for an in-service approach supported by IMTI while Andhra Pradesh might opt for an intensive training course at its well-established WALAMTARI. Karnataka, which does not yet have an equivalent water management institute established, may opt to utilize training courses in one of the other States.

8. The PPC/O&M units may comprise 6 to 8 persons for training from each State. After the final decisions have been taken by the States as to how the individual training should be done, specific training programs could be designed. In any event, refresher courses would be needed half yearly during the first 2 years and thereafter one refresher course per year. New staff members of the PPC/O&M units, which arrive during the course of the project, would receive in-service training as well as participate in the refresher courses. The refresher courses would incorporate any experiences gained so far and would provide increasingly sophisticated training. These courses could be held on interstate basis with rotating chairmanship and would last for about one week.

Training in Engineering Design

9. The new operational plans would have to be supported by revised hydraulic designs. These may include:

(a) Revised control structures in the delivery system some of which could be self regulating, such as long crested weirs with or without gates, improved offtakes and outlets of the baffle type or design of water tight gates;

(b) Design of structures for measuring water flow at specific locations or design of calibrated section throughout the irrigation system;

(c) Design to support operations at full supply levels in all canals whenever they are operated;

(d) Design the delivery system under consideration of water losses;

(e) Advanced methods of lining vulnerable sections.

10. The training would be provided to design engineers of the appropriate department in each State. In total, 21 design engineers would be provided training. Such training could best be done through a workshop to be held initially for 2 weeks possibly organized by IMTI or WALAMTARI. A refresher training for one week yearly should be held thereafter.
Implementation and Operation

11. The training needs for the actual operation of the individual schemes are of a different nature and should not be confused with the above. Here it is of the foremost importance that the staff understands what the new operational plan and agricultural plan are all about. This aspect hardly needs a training program for engineers, as field staff generally interact with the PPC/O&M units in devising those plans (for agriculturists see below).

However, the actual running of the schemes including mastering of day-to-day problems needs careful pre-thinking and training at all levels, which is best done through workshops. A typical example would be to prepare irrigation scheduling along a main canal for an expected cropping pattern or operations supplemental to rainfall. There are many other training needs to be fulfilled, many being project specific, such as on-off operations in lined or unlined canals, regulation of water levels in canals with over-capacity, the feeding of tanks inside the command areas, distribution of water in extreme scarcity situations, yearly rotations, etc. Another aspect of training would be concerned with the intended functions of the physical structures proposed by the PPC/O&M units, particularly the measuring devices, including their construction, and any new types of structures.

12. The agricultural aspects would be fully integrated into the training proposals. These are threefold. Firstly, a general information seminar should explain the role of agriculture in the new plan and what is expected of it. Secondly, the specific task of the agricultural officers should be covered through a workshop type approach, the subjects including, the expected cropping pattern and its crop water requirements at minor or distributary levels, communication with the operational center of each scheme, long-term prospectives, optimizing net return to farmers, etc. Thirdly, workshops are needed to enable agricultural officers to understand the Warabundi system and how it could be integrated with the NWMP if desired.

13. The training for implementation and operation would be at two levels:

(a) **Scheme level Officers** from the ID, CADA, Agriculture Department and perhaps other agencies would receive training focussed on the operational plan proposed so that they: (i) fully understand its objectives and rationale; (ii) acquire the necessary skills for its success, and (iii) are aware of their responsibilities in its implementation. The training program would be developed by the Training Institute in each State working closely with the PPC/O&M Units, and drawing support from other institutions as appropriate. The initial program would be held at the institute or in the project area, and regular follow-up training/discussion sessions would be held in the project area to review performance, resolve problems and ensure new recruits are fully aware of the operational program. The monitoring and evaluation program also requires training, in order to direct involved staff to what type of data are useful in judging the implementation of the plan, and ensuring measures are taken for rectification of problems fairly early in the process. The length of training would differ with type of staff. Engineers would be trained for 2 weeks initially with an annual pre-seasonal refresher course of 3 days over the project period. Operational control staff would be trained for 8 weeks of which 6 weeks would be reserved for data
processing. In sub-projects with main canal operation units, 3 days of specialized training would be provided in addition to the 2 weeks base training. Yearly refresher courses of 1 day would be provided thereafter. Staff involved in monitoring and evaluation would each be trained for one week plus yearly refresher courses of 2 days. CADA and agricultural staff would be given orientation training as well as more training of one week depending upon their degree of direct involvement in the NWMP. Training for organizing farmers would need special skills and thus attentions. A yearly refresher training of 2 days would be provided.

(b) Scheme-level Field Workers (work inspectors/laskar, etc.) would receive a short orientation training of 3 days to ensure understanding and create a collegiate approach to system operations. The Training Institute and PPC/O&M Units would help develop and initiate training courses, but in the longer term, primary responsibility would accrue to the scheme level staff. A regular follow-up meeting of 1 day duration would be held prior to each season to refresh memories, resolve problems and maintain effective participation. Number of staff involved under this category is about 4 per 1,000 ha or about 2,400 persons for the project.

14. Proposed course syllabi for the training of scheme level officers are given in Attachment 1 and for field level staff in Attachment 2. These will be finalized in coordination with the training institutions and the State Government.

Farmer Training

15. Training (or informing) farmers is one of the essential parts of the program. Unless they understand and agree to the system, the entire program may be put in jeopardy. Training would consist, therefore, of explaining the new operational plan and the newly resulting cropping opportunities from it, the need for adherence to schedules, safeguarding the structures and field channels, etc. Two levels of approach to farmers training have proved to be satisfactory. One is the training of farmer leaders by project staff on one-day training sessions at a central location. The other is to visit all farmers in their respective villages through temporary and multidisciplinary field teams. For the latter activity, the teams should visit each village twice before the first irrigation season starts to make sure farmers understand the new system and its benefits (and the losses certain individual farmers are likely to suffer). The above approach should be repeated when Warabundi is introduced at a later date. The farmers' leaders, who have been trained, require retraining to cover any modifications introduced in the operational plan at a later date.

C. Training Facilities

Training Institutions

16. The focal point of training officers would rest with WALAMTARI in Andhra Pradesh, INTI in Tamil Nadu and WALMI in Karnataka. The latter is not fully established but this is expected during the course of the project. These training institutions are in general funded for their routine work from
other sources although finds are included under the project to help complete
the infrastructural development of IMTI in Tamil Nadu (see below). With the
exception, the training component is confined to the NWMP training courses
with costs estimated on the basis of the cost per trainee, together with a
lump sum of Rs 1.5 M to meet any costs that may be incurred for engaging
expertise from elsewhere in India or abroad (SAR, Table 12).

17. The IMTI in Tamil Nadu was launched in 1983 with assistance from
USAID under its Irrigation Management and Training Project (386-0484). A
site has been obtained at the Regional Engineering College, Tiruchchirap-
palli, close to the Cauvery Delt and central to the main irrigated areas in
Tamil Nadu. Work on developing the campus was begun in 1985 following an
architectural competition, and the construction works have been entrusted to
the State Public Works Department. The total cost of the project for a
period of seven years amounts to Rs 30.0 M of which Rs 15.0 M are to be
provided by the USAID loan. It is proposed that the balance Rs 15.0 M should
be met from the credit. Cost estimates are given in the SAR, Table 5.

Scheme Level Training Facilities

18. Training of scheme level field workers and farmers training would be
done at scheme level for which a training-cum-meeting bhall would be erected
together with hostels in larger schemes. The size of the halls and hostels
would vary with size of the schemes. Cost of a typical training cum meeting
hall plus a small hostel is estimated to be about Rs 300,000. Assuming a
total of 20 schemes would participate in the NWMP, Rs 6 M was allocated for
this purpose.

Transport

19. Transport cost to and from training facilities are included in cost
per trainee day listed in the SAR, Table 12. These transport costs at scheme
level may consist mainly of mini-buses. Transport to WALMI's may be by
public transport or mini-buses, transport to farmers meeting may be by jeep.

D. Organization and Management

20. The officer level training courses would be organized by the respec-
tive Training Institute in each State. The GOI Water Management Unit would
organize its seminars and study tours in collaboration of one or other of
these institutes. Each institute would designate an officer responsible for
each scheme. This officer would communicate with the respective PPC/O&M
units at State level as to training programs. The PPC/O&M units may desig-
nate an officer responsible for training aspects of the project in view of
the considerable administrative and organizational work expected. Such
officers would then be responsible to also monitor scheme level field worker
and farmers training programs at each scheme.

21. Evaluation of the training program would be part of the overall
project evaluation done by an outside agency and funded separately. About
50% of the training would be done during the first two years of the project,
followed by 37% during the second two years and 14% thereafter. The SAR,
Table 12 indicates further details as to the proposed timing of the
individual training items.
Training of Scheme Level Officers

Proposed Course Syllabus

A. Engineers (2 Weeks Course)

1. Water Resources
   - River runoff, storage, water available to the project, water rights.
   - Rainfall in the command area, rainfall distribution.
   - Groundwater and its use, water table fluctuation.

2. Existing Irrigation System
   - Original project concept. Area to be irrigated, water allocation policies classification of command-area - wet and dry, water delivery methods, duties.
   - Hydraulic design of main canals, distributaries etc. Design sections, slopes, friction coefficients, losses.
   - Projected cropping pattern, cropping calendars, seasonal and yearly intensities of irrigation, main crops, their varieties, yields.
   - Soil types in the project area, their physical and chemical properties, field capacities, wilting points, available moisture. Infiltration rates, alkalinity and salinity problems waterlogging.
   - Actual performance of the system - reservoir operation, canal releases, areas irrigated in different zones and seasons, O&M staff, works done over the years, O&M expenditures, critical parts of the system, past cases of failures, breaches, performance of conveyance and distribution network, etc.
   - Field observations on carrying capacities of canals, flow measurements, growth of weeks, stability of sections, performance of structures, seepage losses, friction coefficients, etc.
Actual areas in the command area under irrigated and rainfed crops, major crops, their varieties, root depths, critical stages, irrigation requirements, yields, yield response to water, etc., cropping calendars, agronomic practices, farmers preference.

3. Water Requirements

- Evaporation, transpiration, evapotranspiration, potential and actual evapotranspiration.


- Modified Penman method of estimating crop water requirements.

- Irrigation requirements. Effective rainfall, contribution of groundwater, stored soil water, net irrigation requirements conveyance and distribution losses, gross irrigation requirements.

4. The New Operational Plan

- Revised cropping plan. Cropping calendar, crops, area expansion, irrigation intensity, supportive new rules.

- Water requirements for revised cropping plan. Reservoir operation, over-year storage, losses, observation of water rights.

- Water distribution plan. Intermittent versus continuous flow, interval of irrigation, full supply level operations, distribution with limited supply, zoning.

- Operations to meet crop water requirements. Dry season scheduling, scheduling supplemental irrigation to rainfall, consideration of groundwater, use of soil moisture reservoir for supporting peak water requirements, overall water use efficiency.

- Water distribution below the outlet. The principles of Warabundü, significance of field channels, size of service areas.

- Re-use of drainage water.
5. **Implementation**

- Physical Investments and Improvement. Canal capacities, hydraulic structures to support the operational plan, field channel systems, drainage systems, communications, housing office buildings (operation room), current meter, measuring devices, transport etc.

- Organization and Management. Responsibilities, main canal operation unit, operation and maintenance, agricultural supporting services, farmer information and involvement.

6. **Financial Aspects**

- Yields and value of crops; cost of input, net return to farmers, return to society, value of project water.

B. **Operation Control Staff (Six Weeks Course)**

Basic course of two weeks together with Engineers. Thereafter six weeks specialized course in data processing.


2. The structure of a programme, algorithms; flowcharts; programming languages; operating systems.


4. Lotus - elementary use of spreadsheet programs.

5. Data management. Data set specification, records-blocks, volumes, creating data sets, system utilities.

6. Program libraries. program packages, subprogrammes.

C. **Main Canal Operation Unit (Three Days Course)**

Basic course of two weeks together with other Engineers. Thereafter for three days intensified training on:
1. Hydraulics of main canal. Functions of control structures. Operational requirements as to on/off, full supply levels, water advance and recession times, zoning, water losses, supplemental irrigation operations, communications and transport, responsibilities, emergencies.


3. Maintenance of main canal.


D. Monitoring Staff (Five Days Course)

Basic course of two weeks together with Engineers. Thereafter three days course on:

1. Objectives of monitoring.

2. Type of activities to be monitored. Inflow, water use, losses, water distribution schedules, area irrigated, cropping calendars, cropping pattern, type of crops, etc.

3. Statistical analysis of monitored data.


E. Evaluation Staff (Five Days Course)

This course is designed for Senior Officers having substantial knowledge of project operations. For younger staff the basic course of two weeks together with Engineers is a prerequisite.

1. Objective of evaluation.

2. Assessment of project performance based on information collected by the monitoring unit on performance of the new operational plan including area irrigated water allocations, water use, water requirements, cropping pattern and calendar, socio-economic and administrative aspects, policies.

3. Possible alternative cropping plans water allocation and distribution policies - zoning versus allocation per unit area etc. Alternative systems of operation - continuous, on and off or Warabundi. Any other measures to improve equity, reliability and timeliness in water supply, ensure, farmers participation, etc.
F. CADA and Agricultural Staff (Five Days Course)

1. Role of CADA and Agricultural Department in irrigation projects.

2. Background on project engineering and agriculture. Project objectives, water resources water requirements, existing irrigation system and performance, yield response to water, existing crops and cropping calendar, waterlogging, salinity, shortcomings and problems.

3. The new operational plan. Revised cropping plan, cropping calendar, crops, irrigation intensity, area expansion, new rules.

4. Water requirements for revised cropping plan, reservoir operation, over-year storage, losses, water rights.

5. Water distribution plan. Intermittent versus continuous flow, intervals, full supply level operations, zoning.

6. Operations to meet crop-water requirements. Dry season scheduling, scheduling supplemental irrigation, groundwater use, use of soil moisture reservoir for supporting peak water requirements. Overall water use efficiency.

7. Water distribution below the outlet. The principles of Warabundi, significance of field channels, size of service areas, on-farm development work, drainage.

8. Farmers Involvement. Methodology of Organizing farmers for full participation and cooperation at service area and distributary level, election of leaders, establishment of line of contact or complaint to the Irrigation Authority.
Training of Scheme Level Field Workers

Proposed Course Syllabus

(Three Days)

1. Objective of irrigation scheme present cropping pattern, practice of water distribution, tailend and other problems, work duties, powers of canal officers.

2. Water availability at source, concept of crop water requirements, water delivered versus area irrigated, loses in the distribution system.

3. The new cropping plan, cropping calendars and crops, crop-water requirements, supportive new rules on reservoir operation, over-year storage, supplemental irrigation, intermittent irrigation, etc.

4. Water distribution plan. On/off, continuous or supplemental supply to meet crop-water requirements, distribution with limited supply, zoning.

5. Function and operation of various hydraulic structures to support the water distribution plan. Measurement of water flow, operations to full supply levels and its importance.

6. Effect of over and under irrigation on yields and area irrigated.

7. Authorities involved. Irrigation Authority, CADA, Agricultural Department.

8. Farmers participation, organization, line of contract or complaint to Irrigation Authority.