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SUBPROJECT DESIGN REPORT
ON-FARM WATER MANAGEMENT

(Winrock International)

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ACRONYMS

1.	CADA	Command Area Development Authority
2.	CPRWM	Coordinated Project for Research on Water Management
3.	CSCRI	Central Soil Conservation Research Institute
4.	CSSRI	Central Soil Salinity Research Institute
5.	FORP	Farm-level Operations Research Program
6.	HAU	Haryana Agricultural University
7.	IARI	Indian Agricultural Research Institute
8.	ICAR	Indian Council of Agricultural Research
9.	IIMI	International Irrigation Management Institute
10.	IM&T	Irrigation Management and Training Project
11.	IW/CPE	Irrigation Water applied to the Cumulative Pan Evaporation
12.	MPAU	Mahatma Pule Agricultural University
13.	OFWM	On-Farm Water Management
14.	RAU	Rajendra Agricultural University
15.	TNAU	Tamil Nadu Agricultural University
16.	USAID	U.S. Agency for International Development
17.	WALMI	Water and Land Management Institute
18.	WTC	Water Technology Center

I. EXECUTIVE SUMMARY

This proposed On-Farm Water Management (OFWM) subproject will be supported by USAID and ICAR under the Agricultural Research Project. The OFWM subproject is designed to provide five years of (Phase I) support to ICAR to strengthen on-going research and implementation efforts in its Coordinated Project for Research on Water Management (CPRWM), with particular emphasis given to on-farm water management. The ICAR Project Directorate for Water Management has given highest priority to strengthening research that focuses on those portions of the irrigation command systems below canal outlets. The primary objective of this subproject effort is to assist ICAR in improving its institutional capability to expand the relevant research knowledge base and increase the rate of adoption of research based technology and practices, so as to facilitate increases in water savings, crop yields, farmers' income and overall net benefits from irrigation investments over time.

The proposed subproject focuses on strengthening and complementing ICAR's OFWM research program through ten major activities. These are:

1. Work plan formulation, involving initial exchange visits by key ICAR OFWM project administrators/scientists and experienced U.S. OFWM scientists.

2. Assist ICAR in conducting its on-going OFWM research program during the life of the subproject.

3. Providing basic and specialized equipment, and the necessary training to operate it, as needed.

4. Providing funds for a package of resources for innovative research projects through a competitive grants program.

5. An ICAR visiting scientists to U.S. program.

6. A U.S. scientists visits to India component.

7. Assistance in developing and delivering in-country short courses and workshops.

8. A graduate student exchange program.

9. Conducting formal, mid-project and near end of Phase I program evaluations.

10. Design input for Phase II.

The planned utilization of U.S. scientists with OFWM research experience will be drawn largely from faculties at U.S. land grant universities, and the U.S. study tour component for Indian scientists would be heavily concentrated on such campuses. Thus, the contracting entity for this subproject will require direct U.S. university involvement. The contractor would be expected to provide long-term (5 years) manpower for one scientist/coordinator position in the U.S. and one such position for the first two years, and a half-time logistics person in-country. The remainder of the technical assistance manpower inputs would consist of a series of short-term visits by U.S. OFWM scientists, including but not necessarily limited to, soil scientists, crop scientists, agricultural engineers and economists (including personnel with experience in computer applications and data base management). Such scientists would be involved in joint research and/or in-country training activities in the ICAR OFWM program. Particular emphasis would be given to the Farm-Level Operations Research Program (FORP) effort which was recently initiated by ICAR and has now been elevated to highest priority.

The total projected budget for sustainable OFWM subproject activities during Phase I is approximately $5.90M, net of inflation. Estimated costs for the major components are as follows:

Contract to U.S. Subproject Entity (for subproject administration, program delivery and coord.) (90 mo.)	$ 1,321,461
Scientist Exchange Program	
Indian Scientists Visits to U.S. (267 mo.)	704,700
U.S. Scientists Visits to India (114 mo.) (incld. 1 scientist full-time for 2 yrs)	1,653,499
Graduate Student Exchanges (290 mo.)	770,600
FORP Staff Training & Orientation Tours (20 mo.)	150,000
Equipment Support	1,300,000
Total Estimated Subproject Costs	$ 5,900,010
Inflation Factor (12%)	708,001
Total Adjusted Cost	$ 6,608,011

Note: See also tables 2, 3 and 4 in Section V - Financial Plan

Given the likelihood of an overall USAID budget constraint that may result in a funding level short of the projected total budget requirement, options for joint funding with other USAID and/or other donor agencies' similar projects may have to be considered. As a last resort, the level of effort in some of the projected OFWM subproject activities could be delayed until the Phase II time period. This would be a "second best" option, for two reasons. First, it would not significantly reduce the U.S. contracting entity's administrative and delivery costs and second, overall project performance would suffer substantially, due to dilution of the "critical mass" of scientists

required for the program to have a significant improved institutional capability impact during the Phase I time period.

The ICAR-OFWM research program is on-going and long-term. Its recently implemented FORP efforts in collaboration with the Command Area Development Authorities (CADAs), Irrigation Departments and other state level entities likewise will require long-term time frames if the overall goals of substantially increasing crop yields, farmer incomes and project benefits are to be achieved. Therefore, USAID support for these programs ideally should also be viewed as a long-term commitment. Phase I of this subproject would then only be the starting point for such a long-term endeavor.

II. BACKGROUND

A. Introduction

The Government of India has given high priority to irrigation systems development in each successive five-year planning effort. At the start of planned development programs in 1950, it was estimated that 22.6 m.ha. were under irrigation (adjusted for cropping intensity) out of an estimated potential irrigation development capacity of 113.5 m.ha. At the present time, an estimated 65 m.ha. have been developed for irrigation and essentially the total capacity of development is planned for implementation by 2010. Significantly, the development of the minor irrigation component - primarily consisting of tubewell development which has contributed a disproportionately high share of recent irrigation productivity increases (the Green Revolution) - will likely reach the economic limits of development by the year 2000 or before (Dhawan, 1983).

Overall, crop yields in India remain low -- far below station tested levels, on rainfed and irrigated land alike. "The rate of overall crop yield increases has been falling and agriculture has stagnated in some parts of the country" (World Bank, 1985). Given these parameters, it is readily understandable why India's public policy emphasis is now being placed on improved management of existing irrigation systems, which account for most of the total agricultural outputs, and why there are widespread efforts to increase the farmers' rate of adoption of research-based technology and recommended practices.

The development of Indian agriculture has been analyzed as consisting of three overlapping stages (Seckler and Sampath, 1985). Stage I, which continued until the late 1960s, was a period of growth in agricultural production output that was primarily dependent on the development of cultivable cropland, both irrigated and rainfed. Stage II, beginning in the late 1960s and likely to end by 2010, has been characterised by accelerated irrigation development, adoption of high yielding varieties (HYVs) and increased applications of commercial fertilizer (NPK), with the latter two heavily concentrated on irrigated lands. As noted above, however, the initial large increases in output during this period were closely correlated with tubewell development and as the shift toward developing the remaining more resource constrained canal irrigation potential continues, output increases have at best been increasing at a decreasing rate. With the beginning of Stage III, by 2010, virtually all additional increases in production will neccesarily have to depend on increased yields and cropping intensity through adoption of biochemical technology and improved on-farm irrigation management. Thus, the role of irrigation management research that is geared to improving the rate of adoption of recommended practices and inputs will continue to become increasingly important in the future.

B. Scope and Objectives

It is neither possible nor desirable to deal with the total national effort to increase agricultural production within a single organizational unit or donor supported project. In this instance, the focus will be on improving quantity and quality of the research and the rate and scale of adoption of research results emanating from the Project Directorate on Water Management within the ICAR. Specifically, ICAR has asked the U.S. Agency for International Development (USAID) to assist in implementing an on-farm water management (OFWM) research subproject under its on-going Agricultural Research Project. This OFWM sub-project design effort will focus primarily on a phase I period of five years, even though the ICAR OFWM research effort is viewed as requiring a long-term program effort.

It is important at the outset to place this initial USAID sub-project effort into perspective within ICAR's on-going overall coordinated water management research program. Its Coordinated Project for Research on Water Management (CPRWM) was first sanctioned in April 1967, with establishment of research centers at Hissar, Chahuli and Siriguppa that were closely tied to three major river valley irrigation schemes. A Water Technology Center (WTC) was established at the Indian Agricultural Research Institute (IARI) in New Delhi in 1970 and a WTC was established at the Tamil Nadu Agricultural University (TNAU) in Coimbatore in the mid 1980's.

In the interim, three coordinated projects dealing with various subject matter components (e.g. soil, salinity, irrigation, drainage, cropping patterns, water conservation on hill lands, etc.) were established at 29 other centers throughout India, with 23 of them located at the agricultural colleges and universities. These individual research programs have now been consolidated into ICAR's CPRWM and elevated to a Project Directorate during the current (7th) Five Year Plan. (ICAR - For the Seventh Plan, 1985-90). In addition to continuing irrigation water management research at the 34 centers already established, it is planned to establish two additional WTCs, one for the eastern region and another for the central region, with the latter to house the Project Directorate for the total ICAR research system for irrigation water management.

ICAR has specified a set of objectives for its OFWM research component to which USAID has been asked to provide financial support, as follows (ICAR, March 1985):

1. to improve efficiency of on-farm water management;
2. to strengthen basic research for evolving efficient methods/techniques of on-farm water management;
3. to evaluate socio-economic and environmental aspects of water management.
4. to disseminate the knowledge gained in research ....

"The broad basis of the above objectives is to strengthen the technical expertise through intensive studies and to disseminate information to a large group of specialists working in the area of on-farm water management" (Ibid).

During an initial briefing meeting of the design team members by the ICAR and Project Directorate administrators (ICAR, 19 January, 1987), the first priority status of the on-farm water management research component was duly stressed. Further, two major thrusts of this effort were identified, as follows:

1. Increasing basic research performance of the network of 34 centers, with emphasis on the role of four WTCs.

2. Expanding the OFWM research and demonstration effort to the irrigation command area and farm levels, in close coordination with nine selected irrigation water delivery organizations located in nine agro-climatic zones -- and in CADAs wherever possible.

These farm-level irrigation command area oriented (FORP) efforts represent the most recent evolution in ICAR's water management research program. Most of these "operational research program" efforts are still in the early implementation stage, most of them with two years experience or less, and several are still in the design stage. As originally designed, the FORP research teams will be interdisciplinary, consisting of soil scientists, crop specialists, irrigation engineers and social scientists (as a minimum, including an agricultural production economist, but ideally also a person skilled in organizational and institutional matters).

We noted common usage of the term "Operations Research Program" by ICAR to define the farm level work scheduled in one or more irrigation minors within irrigation command areas. In the scientific literature, "operations research" means something entirely different - a highly quantitative field of endeavour not unlike the field of econometrics. Therefore, in order to forestall confusion in the future as articles on this command area based element of ICAR's research emerge in the scientific literature, we recommend a modification of its terminology to "Farm-level Operations Research Program" (FORP). We will use that term in this report.

The nature of the FORP to be carried out operationally within the command areas will necessarily be very site specific. Three general program objectives have been set forth by ICAR to coordinate these efforts; these are:

" 1. to study the present (water) utilization pattern and to test the improved water management technology developed at the research centers with a view to improve the efficiency of water use;

2. to study the impact of improved water management practices on agricultural production and economic benefits in the command area; and,

3. to generate more effective water management technology to facilitate more efficient use of natural resources." (Ibid)

The Scope of Work document provided by USAID for our OFWM design team of this sub-project of the on-going Agricultural Research Project (USAID/New Delhi, June 12, 1986) specified an overall objective, as follows: ".... to develop a systems-based methodology that will permit a holistic analysis of measures needed to improve the predictability, utilization, and return flow of water in any specific irrigated area of the country." Further, "this sub-project is aimed at developing a methodology for analyzing irrigation systems for determining improvements needed". Per the Scope of Work, USAID proposes to provide assistance to ICAR's OFWM thrust via provision of technical upgrading of scientists and data base management, equipment and short-term technical assistance from U.S. scientists from the various disciplines involved in OFWM.

While the above stated subproject objectives focus primarily on methodology, the design team members determined, on the basis of our field visits and discussions with various in-country OFWM experts, that a more appropriate role for this USAID assistance effort would be to focus it primarily on process. The reasons for this shift in emphasis are that ICAR's OFWM effort is already on-going, the basic approach has now expanded to the field research phase within irrigation command areas, and ICAR is committed to an interdisciplinary team approach. Hence, the "holistic", systems analysis focus below the canal outlet envisioned in the scope of work can be met by ICAR's current approach, with appropriate modifications. Therefore, the team proceeded to design USAID-funded assistance in carrying out the process by strengthening ICAR's OFWM institutional capacity and its linkage to state-level delivery organizations (e.g. CADAs, Irrigation Depts, Extension). The means for accomplishing this modified subproject objective will be via 1) strengthening ICAR's on-station research capability and 2) implementing and strengthening its FORP efforts, so as to facilitate an increased rate of adoption of recommended technology and practices by farmers and water delivery authorities over time.

Specifically, the OFWM subproject objective will be to assist the ICAR Project Directorate to strengthen its institutional capacity in its OFWM research to expand the relevant knowledge base and to increase its rate of adoption, so as to in turn significantly increase water savings, agricultural production, farm incomes and project economic benefits

within whole irrigation command areas.

To this end, project components will be identified that will include but not necessarily be limited to: 1) improving the capability of relevant ICAR scientists and administrators via in-country training and U.S. study tours; 2) provide equipment designed to increase the research capability and the synthesis and analysis of research results (e.g. computers, field-based equipment, data-base management needs, etc.); and 3) provide for access, on an interdisciplinary basis, to U.S. irrigation scientists via short-term in-country assignments to assist in this effort.

We do realize that on-farm water management cannot be divorced from the complete irrigation system, nor should it be, since the water delivery policies and practices of the irrigation departments bear heavily on the effective and economical use of water and capital investment on the farm. The linkage mechanism options between this subproject and other on-going irrigation development and management efforts will be dealt with in a later section of this report.

C. Summary of Team Visits and Major Findings

1. A Sampling of Research Centers and Field Sites Visited

The design team's itinerary included visits to a number of institutions, which are all involved in one way or another with the ICAR's CPRWM (See also Rajput, R.K., 1986 and Appendix, Item 1). Research institutes and universities visited included:

Haryana Agricultural University (HAU), Hissar
Central Soil Salinity Research Institute (CSSRI) , Karnal
Central Soil Conservation Research Institute (CSCRI) , Dehradun
ICAR Water Management Project, Tamil Nadu Agricultural University, TNAU at Madurai
Water Technology Center, TNAU at Coimbatore
Mahatma Pule Agricultural University (MPAU), Rahuri
Water Technology Center, IARI at New Delhi
Rajendra Agricultural University (RAU), Pusa

Visits to four of the ICAR FORP sites -- Bhavani Sagar (TNAU), the Mula project area near Makinopur in Maharashtra (MPAU), the ICAR field project site near Madurai (TNAU), and the Gandak Command Area near Motihari in Bihar (RAU) were included. Brief visits were also made to the Water Resources Training Development Centre at Roorkee University, and the Agricultural Engineering facilities at Sukhadia University. Visits were made to Water and Land Management Institutes (WALMIs) at Aurangabad and Patna. In addition, the team attended the four-day XI Annual ICAR Project Coordination Workshop held at Sukhadia University in Udaipur, during February 9-12, where reports were given on relevant research activities at all 34 centers involved in the CPRWM.

While it is likely that some significant ICAR work in progress on water management research may have escaped our attention, the design team feels that our exposure has been sufficient to give us a reasonably accurate picture of the current state of the research activities underway within ICAR's CPRWM. Rather than attempt a location by location report, we shall confine ourselves to a general discussion of the program as perceived by our team, including both current strengths and identification of those areas which can be strengthened and thus are appropriate for particular attention under this proposed ICAR/USAID OFWM subproject.

2. Soil-Water-Plant Relationships

At virtually all sites visited, the team observed a number of field trials on "irrigation scheduling". Treatments imposed typically included variables such as irrigation at specific growth stages, irrigation to achieve specific values of the ratio of irrigation water applied to the cumulative pan evaporation (IW/CPE), or a specific number of irrigations (at specified delivery levels) applied to a particular crop. Additional variables such as fertilizer rates or weed control methods were sometimes included in the treatment set. For paddy, experiments at many locations involved non-continuous submergence treatments with irrigation applied at varying times after the recession of the water level from the soil surface.

Many experiments involved varying cropping patterns, using a variety of crops and cropping sequences in an attempt to identify cropping sequences that might be more profitable than those presently employed and/or better suited to the amount or timing of available water supplies. The field experiments we observed appeared to be well managed and conducted in a professional manner, although inconsistencies were noted in how "profitability" was calculated.

While we could observe only a small part of the on-going operations during our field visits, it seems a fair assumption that data obtained from such experiments would generally be reliable. On a less positive note, treatment sets often consisted of a somewhat non-systematic combination of discrete and continuous variables. Where continuous variables were tested, e.g. effect of IW/CPE ratio on nitrogen fertilizer rates, they were generally analyzed and interpreted as if they were discrete. There seems to have been little or no attempt to interpret these experiments in terms of response or production functions, such as are commonly used in production/economic analyses.

Lysimeter installations are operating at several locations. These are locally constructed units that generally seem to be operating satisfactorily and it appears that reliable data are being collected. Sensitivity is good (quoted in one case as 0.14 mm) and certainly appear adequate for determining crop water use, at least on a daily basis.

Some ICAR researchers expressed a desire for more sophisticated lysimeter installations, utilizing digital recording at frequent intervals and simultaneous recording of a sophisticated set of climatic parameters. This equipment would be utilized in the development of and validation of sophisticated crop growth/water utilization models. Such models rely on combining the principles of soil and plant processes as driven by climatic variables to simulate, or calculate, water use and crop response to water stress. It should be understood, however, that this proposed approach is quite different from the current empirical method of attempting to establish optimum "irrigation schedules" through field trials, using some subset of the infinite number of possible irrigation regimes.

The design team believes that the present empirical approach should be rapidly supplemented by a more mechanistic approach to understanding crop water needs. However, this does not necessarily translate to a recommendation that large sums be spent on a series of sophisticated lysimeter installations. With a limited financial resource base, such installations can only be acquired and operated at the expense of support for other program elements. Furthermore, they are best suited to short time scale process modelling, while the greatest practical utility probably lies in the use of meso-scale models, perhaps based on daily time steps. Development of such models, or adaption of existing models of this type (see Reuss, 1980 for an example), can well be done with less sophisticated instrumentation applied over a wider range of crops and climatic conditions.

In general, however, the current level of research based on application of fundamental principles is too limited, while empirical on-station field trials are perhaps over-emphasized. There are, of course, exceptions such as the stress physiology investigations and the soil chemistry/soil water modelling efforts underway at HAU at Hissar. We also noted a much more mechanistic approach to irrigation timing at the WALMI at Aurangabad.

Almost all locations reported that with careful attention to irrigation applications and timings, crops could be successfully grown on much less water than currently used by most cultivators, with little or no reduction in yield in most cases and even with yield increases under some conditions. In the current OFWM research effort, recommended practices tended to produce about current or slightly increased yield levels with about a 40% saving in water. On the one hand, this is encouraging, as it indicates a potential of greatly increased production without an increase in total water supplies. On the other hand, it is also apparent that under current farming conditions, water saved in this manner is unlikely to be translated into increased production, given the current level of uncertainty in water deliveries. Follow-up FORP efforts on these aspects under actual farming conditions found within irrigation command areas is now needed.

The underlying reasons for apparent lack of farmer response to demonstrated water saving potential are many. For instance, unless reservoir or in-line storage is available, water saved during times when plenty of water is available at the field level has little or no economic value, and may actually present a disposal problem. Even if the water supply is scarce, redistribution of saved water in a manner that will increase productivity may require major modifications in the manner in which the storage and delivery systems are operated and perhaps in system hardware as well. Political and social factors involved in redistribution can also be major deterrents to effective on-farm utilization of water saved. Finally, the farmer who must modify his practices to attain such saving of water may not be the one who benefits and the risks of obtaining water for later season irrigation may increase, so there is little incentive for adoption. Such problems point up the need for effective cooperation between the ICAR research staff and the CADAs, Irrigation Department, Extension Service and other state level agencies that supply farmers with inputs.

3. Agricultural Engineering

Agricultural engineering related work appears so far to have received relatively less emphasis than the agronomic aspects even though most ICAR stations now have agricultural engineering staff. Still, a substantial amount of work is underway such as the design of surface irrigation systems, the construction of shallow cavity wells, and a pump testing program at RAU and elsewhere. Trials involving sprinkler irrigation, border and ditch design and methodology, alternate furrow irrigation and the like which involve agricultural engineering aspects are also being conducted on a limited basis by researchers at some stations.

Researchers at several stations are also investigating drip irrigation methods, particularly for orchards, sugarcane and some vegetable crops. The potential for drip irrigation adoption by farmers seems to be substantial, particularly where water supplies are limited and where lands with topography and soil depth limitations can be brought into production, but where other traditional methods of irrigation are impractical or economically not viable. Almost universally, substantial water savings have been demonstrated in these experiments. In the design of drip irrigation systems, however, basic data on the response of the crop to different stress levels, irrigation frequency, the optimal fraction of the rootzone irrigated, and the soil moisture distribution in the rootzone under continuous and intermittent application of water with different flow rates is essential. There does not seem to be very much emphasis on these aspects of drip irrigation research in the current trials at various centers, except at the WTCs of IARI and TNAU.

Drainage problems, both surface and subsurface, are widespread, and we found subsurface drainage experiments under way at several locations.

Perhaps the most sophisticated drainage related work that we observed are the experiments involving skimming wells, and the disposal or re-use of saline drainage water at HAU at Hissar and the sodic soil reclamation work at CSSRI at Karnal. On the other hand, research efforts related to the need for surface drainage, which is particularly important during the monsoon (Kharif) season, are minimal.

Mathematical, computer-based models to simulate flow of surface irrigation water based on research elsewhere are readily available. The scientific journals are replete with models that can be used to study the effect of field variables on the flow of water and on irrigation system performance. Use of above noted models should supplement or largely replace the field studies envisaged for continuation by the CPRWM. Once the site specific values for the systems variables are available, these models can be used to obtain, without field experiments, the optimum length and width of the field, the optimum inflow rate, etc. Since the output from the model will be only as good as the input, however, research emphasis should be concentrated on testing and validating these models and on development of improved methodologies for estimating values for system design variables.

Similar reasoning applies to research on subsurface drainage. Instead of conducting field experiments to obtain optimum drain spacing and depth, available mathematical models can be used to calculate optimum drain spacing and depth in any given area, if site specific information on soil-water-plant-atmospheric relationships is available or can be developed in ICAR's OFWM research.

The most common outcome of the research presently being conducted on station test plots seems to be related to the optimum number of irrigations of some specified amount at some specified crop growth stages (the irrigation scheduling, the "when" and "how much" aspects). In the trials underway, however, there is no emphasis on the design ("the how") aspect of surface irrigation. The above mentioned mathematical models can be used to design surface irrigation systems. Without an appropriate design, there is no guarantee that the depth of water applied by the farmer would be equal to the "optimum" depth of application found from the experiments. This is particularly so in the case of an unlevelled field with undependable water supply.

Even though land grading or leveling is an important (necessary but not sufficient) condition for improved OFWM, ICAR research on the land leveling aspect seems to have taken backstage. To derive maximum net benefits from irrigated agriculture, however, recommendations on irrigation scheduling, land leveling, and design of irrigation/drainage systems should be provided as a package. The research station at Karnal has developed a general relationship between the degree of levelness and the application efficiency. One must be careful in extrapolating the results to other sites however, because that relationship is sensitive to the soil type and the distribution of the high and low spots in the fields.

The ICAR scientists who attended the XI Annual Water Management Workshop at Udaipur complained about inadequate or, in some cases, total lack of cooperation from the CADA or the Irrigation Department personnel in their FORP efforts. Without this cooperation, it is highly unlikely that a dependable water flow rate can be obtained at the farm. Continuation of the undependable water supply at the farm would hurt the credibility of the researchers in their FORP efforts, and would hinder progress in achieving the adoption of on-farm water management technology and research recommendations. Therefore, efforts to establish formal agreements with CADA's and Irrigation Departments for the role of FORP efforts by ICAR staff are of highest priority.

The micro-network below the canal outlet, which may be designed and constructed by the CADAs, is a prerequisite for improved water management at the field level. However, in the absence of quality of construction and annual maintenance, the infrastructure (hardware) facilities will not be able to achieve the original objective of providing the required quantity of water at the farmer's field. In addition, even with best of intentions, the lack of or inadequate communication between the CADA and/or Irrigation Department field officers regarding the actual crop water demand pattern would result in undependable water supply to the outlets. During our field visits, in some cases we found the minors flowing full even when the demand for water was not very much and in other cases the canal system was shut down while farm crops were under severe stress. Discussions with Irrigation Department officials revealed the problem of communication as to the actual water requirements of each minor, and/or distributary during a given season. And, even if known, some capacity limitations of the system may preclude major adjustments in delivery schedules.

Lack of attention to the above listed problems continue to nullify the level of benefits due to improved water management efforts at the farmer's field level. The net result is reluctance on the part of farmers to adopt the improved on-farm technology recommendations that are presently being provided to them. More serious consideration should be given to removing these kind of constraints.

Available information on approximate estimated evapotranspiration rates (Hargreaves, et.al, 1985) along with the actual cropping pattern in a given season in the command area of a minor, distributary, etc. is not presently being used to calculate the outflow hydrograph from the sluices/outlets. For improved water use efficiency this exercise should be repeated during each season. This calls for efficient communication channels between the outlet and the upstream gate operators.

In addition to testing improved technology at the field level, the FORP of ICAR should give greater emphasis to improved distribution of water below the outlet. The following aspects may be considered and, hopefully, implemented:

1) Improved alignment of channels;
2) Improved quality of construction;
3) Development and testing of simple, sturdy, and economical small structures; and
4) Improved subsystem operation and maintenance through Water Users Associations, hired labor, etc.

4. Economics/Organizational/Institutional

There are several types of economics research and evaluation activities that are deemed necessary within a fully integrated, inter-disciplinary team approach in ICAR's OFWM research program. These can be broadly specified as: 1) Macro level analyses and policy-oriented studies; 2) Economic analysis of biological/physical research components, initially under station conditions and then as modified FORP efforts, 3) Farmer-oriented studies - both of individual recommended practices and whole-farm budget impacts; 4) Evaluation of impacts of adopted practices, by both farmers and water delivery schedulers at the command area level (to be reflected in increased yields, rising net farmer incomes, expanded infrastructure, and equity considerations over time); and, 5) An on-going analysis of benefit/cost ratio adjustments for public investments in irrigation development at the project level. The inclusion of agricultural economists as legitimate members of ICAR's OFWM teams is a relatively new phenomenon and at present few of the anticipated positions have been sanctioned and even fewer of them have been filled. Rather than viewing the present situation as a matter of undue alarm, we view this as an area of significant opportunity for USAID institution building support efforts under the OFWM subproject.

The studies envisioned under items (1) and (5) above can most effectively be carried out by economists stationed at each of the present and proposed WTCs. Ideally, in order to generate the greatest impact on public policy deliberations, such activities should be carried out by senior agricultural economists stationed at the four proposed WTCs who are fully trained in micro-computer based methodology. In practice, a few studies of this type are presently being carried out at minimum performance levels at the WTCs in New Delhi and Coimbatore and at the CSSRI at Karnal. In addition, selected PhD dissertation topics at both agricultural and non-agricultural universities have focused on these study areas but to date have not generally been coordinated with the OFWM Project Directorate Program. Examples of ICAR work done or to be coordinated with that effort are the studies being carried out by the economists (Joshi, and Agnihotri, 1984) and a truly interdisciplinary study by a team of two economists and one engineer (Agnihotri, Joshi and Singh, 1985) at the CSSRI at Karnal.

A recently sanctioned ICAR regional economic research project, "Conjunctive Use of Ground Water and Surface Water for Optional Irrigation Management and Cropping Patterns in River Basin Projects under

Different Rainfall Situations", is also noteworthy. Four such regional studies have recently been sanctioned. In summary, major emphasis on these types of macro and regional policy-oriented studies should be given at the four proposed WTCs (although some individual policy oriented efforts by economists at the other stations have been suggested to us and should not be discouraged.)

In general, the economic aspects of the on-station and FORP research efforts, e.g. areas 2), 3) and 4) noted above, lag far behind the agronomic and engineering aspects. Economic interpretations of field plot experiments tend to be minimal, and, when present at all are done in an inconsistent manner. Part of the problem is that many of the biological/physical experiments were not designed in a manner conducive to effective economic analyses, e.g. the determination of single or multi-factor response functions. At the field plot level, economic analyses should be planned at the experimental design stages. To date, the socio-economic components of the FORP efforts have been largely limited to bench mark surveys. But, various levels of economic analysis, including enterprise budgets and farm budgets for different irrigation, fertility, and cropping regimes, and long term monitoring and evaluation on the watercourses or minors selected for FORP efforts, are now needed. The OFWM subproject could serve a very useful function in helping to strengthen these areas of single or multi-factor response functions. Economic analyses of this type should be planned for at the exprimental design stage for plot experiments.

Given the apparent shortage of PhD economists, it is likely that in order to add economists staf at all centers, some master level personnel will have to be recruited. This is not viewed as a serious limitation because if such personnel are given additional short term training in appropriate methodology, we believe that they will be able to carry out their station responsibilities quite well.

Economics input in the farm level research programs (FORP) within the CADAs is practically non-existent, which is not surprising given that the FORP efforts are in the early stages of implementation. While so-called socio-economic base surveys are carried out prior to the implementation (presumably to be followed by an end of project survey to estimate the magnitude of change that has taken place) it must be recognized that most such efforts that we reviewed are <u>not</u> economic studies or analyses. At best, they constitute a "benchmark" set of data and, even then, in their present format, the data obtained are generally inadequate for economic analysis. There were exceptions found at Mahatma Phule Agricultural University, however, where some studies done for total command areas were quite comprehensive and included a good analysis of variations in farming characteristics by size of unit (Dhongade and Dangat, 1985). Overall, however, there is need for considerable improvement in economic surveys and analysis applied to ICAR's FORP.

Per ICAR's objective 2 for the FORP, "to study the impact of improved practices on agricultural production and economic benefits in the command area," the bench mark survey data to be obtained requires estimates of pre-project production levels and farm incomes. Obtaining reliable estimates thereof requires sample disaggregation by size of farm so that weighted averages of production and incomes can be obtained. Further, to analyze impact, continual monitoring and evaluation is much preferable to simply comparing pre-project conditions with conditions at some future point in time. The latter may tell you something about "how much" but not "why". The key element in improving rates of technological adoption is in understanding why or why not some change is/is not taking place. Such studies in the FORP sites need not necessarily be conducted by ICAR senior staff; supervision of junior staff and/or graduate students doing thesis or dissertation research would be an acceptable approach. The technical assistance component of this sub-project could serve a very useful function in helping to strengthen the economic research and evaluation elements presently missing in ICAR's OFWM research program.

At the present time there is no apparent input from sociologists (and/or other social scientists) who are skilled in organizational and institutional aspects, other than perhaps in the design of the socio-economic base survey questionnaire. While such scientific input is not crucial for the on-station research, it is absolutely essential at the command area level. In this regard, assistance will be needed in developing useable approaches to farmers directly and via the Extension Service, in the establishment of farmers' Water Users Associations, and in forging viable working relationships with CADAs and Irrigation Departments.

In addition, the OFWM subproject can be helpful in improving and strengthening the horizontal linkages among state irrigation entities particularly with regard to the identification of research needs, collaboration and coordination among the various state entities involved and assistance in carrying out and sharing of information about the research and its implications with other concerned organizations. The subproject can serve as one of many focal points for improving these technical and horizontal linkages and also the relevance of research particularly among Irrigation Departments' Central Design Organization, Central Groundwater and Drainage entities, Water and Land Management Institute's Action Research Programs and other private or Non-Governmental Organization research entities.

Some mechanisms that can be identified under the current proposal for strengthening horizontal linkages under FORP assistance that should be considered are:

1) The encouragement of collaborative (or joint) research activities with relevant and concerned operations based organizations (i.e. Irrigation Departments) and among other research organizations.

2) The development of technical work groups for particular research areas both within the state and among other state entities.

3) The funding within research proposals of short visits among collaborating scientists, operational specialists and other information sharing activities should be encouraged.

4) Also the subproject should encourage the development of memoranda of understanding to forge the horizontal linkages among potential participating entities. These memoranda should describe the terms of the research and potential output.

5) The development of a research advisory team at the state level which would have an input into the decision making process for approving and funding research should also be considered.

6) The development of a state level review process to discuss the research results and application opportunities would be highly desirable.

Given the dearth of rural sociologists in India, however, there is little likelihood of staffing such positions at all ICAR centers with FORPs. As a minimum, however, attempts should be made to fill sociology posts at one or more of the WTCs and then, initially, have them supported by some institutional economists (versus only production oriented economists) at the other centers.

5. Computing and Data Processing:

At each location visited, we enquired as to the computing and data processing facilities available, and the tasks for which the facilities are being utilized. Most locations visited had at least one desk top micro-computer. Typical utilizations were for traditional analyses of variance of field experiments and occasional use of computerized linear programming models by the economics staff. With a few notable exceptions, e.g. the soil water/soil chemistry modeling at HAU and the energy balance approach to crop water requirements taken at the Aurangabad WALMI, computers were not being used by individual scientists in their day to day research, and relatively few staff are cognizant of the potential of computers in this regard. In the opinion of the design team, the failure to keep pace in the computer applications area is probably the most important deficiency in the current overall ICAR water management research capability.

The potential of modern micro-computer technology can only be realized, however, when scientists are trained in relevant applications and the equipment is available to the scientist for day to day use. Fortunately, modern technology has lowered the price of the relevant hardware to the point that rapid adoption by ICAR scientists now appears feasible. Therefore, the design team believes that this area of support should be a major focus of the proposed OFWM sub-project, including acquisition of appropriate hardware and software, training in applications, and assistance in staff utilization.

The problem of aggregation and synthesis of research results is closely related to the computational and data processing capability. The coordinated research approach adopted by ICAR has demanded a commonality of experiments within agro-climatic zones. However, the interpretation has been almost entirely location specific. No examples of aggregation or synthesis across locations have come to our attention. The problem of treating continuous variables as though they were discrete variables has been previously mentioned; but, it is relevant here also in that the response function type of design and analyses is particularly well suited to synthesis of data over locations and years. The availability of computer equipment and development of utilization skills should greatly facilitate the establishment of appropriate data bases and the synthesis of results over time and location. As this occurs, attention can then be given to developing a central data base at one or more of the WTC's that would be readily accessible by scientists at the various other centers. Assistance in developing a central data base system and acquiring the necessary computer hardware and software to make it operational would be a viable component of the proposed OFWM subproject.

III. SUBPROJECT DESIGN STRATEGY

A. Project Management

Given that the proposed OFWM subproject to be funded by USAID is a strengthening support effort for improving institutional capacity for an on-going ICAR program, the subject matter focus is already firmly established. Based on our review of on-going research in a sample of ICAR centres and field stations, however, there are several areas in which subproject support can be of assistance in strengthening ICAR's overall water management research program and, in particular, can assist in implementing the FORP effort that has only recently been started.

The types of assistance that could be provided can be broadly categorized as follows: 1) Scientific manpower development, including both a fellowship program for post graduate (non-degree) short terms in residence (6 to 10 months) at U.S. universities and delivery of short-courses in-country; 2) Equipment, both for data base management and to complement on-going research; and 3) Technical assistance to be provided primarily by a series of in-country short term assignments for a number of U.S. scientists from the various disciplines involved in OFWM research. Delivery of these components in a cost effective and continuous flow will be the primary management challenge of this subproject.

1. Areas of Emphasis

USAID support for ICAR under this subproject can be broadly divided into three institution building oriented categories: 1) Support for research design and administration, data base synthesis and management and associated research at the WTC's; 2) Support for on-station research at the remaining ICAR locations, and 3) Assistance in implementing the new FORP effort in concert with CADA and Irrigation Department managers in selected irrigation command areas, hill areas and other minor schemes, and the like. A number of areas of potential subproject irrigation support have been noted, based on our field visits, for the WTCs and other on-station research. Because the FORP effort is still in its early implementation phase, however, support emphasis for it will likely have the highest potential for long-term payoff (e.g. have the greatest impact on improving the rate of adoption of research-based technology and recommended practices) but it will not necessarily require a disproportionately large share of available project budget. Specific recommendations for the three broad categories will be outlined in following sections of this report but a general summary for each area follows immediately below.

Subproject support for personnel in the WTCs would certainly include an initial short-term tour for key ICAR administrators/scientists of U.S. facilities where OFWM research expertise has been identified. It would include an option to provide short-courses in managerial science

for them and assistance in implementing a computer-based data management system. It would also include longer U.S. study and observation tours for WTC senior scientists engaged directly in research. Finally, provisions would be made for use of U.S. scientists to assist the WTC's efforts via short-term, recurrent visits to India.

A large portion of the OFWM subproject support effort will likely be for researchers at the various other ICAR stations,m including the programs at 23 cooperating agricultural universities. Included would be a number of longer-term, say 6 to 10 month, study tours at U.S. universities (and/or including intership at cooperating federal research centers) to work with their senior scientists. In addition, training in new research methodology and use of micro-computers in data synthesis and analysis would be provided, both in-country and in the U.S. Equipment support and opportunities for U.S. scientists to visit India on a short-term, recurrent basis would also be provided.

Subproject support for the FORP effort will likely be the most difficult to manage, partly because this is a relatively new program within ICAR but also because there are only limited case studies of such an approach that can be observed anywhere in the world. Included in the support effort, however, would necessarily be some group training of the identified inter-disciplinary teams on how to "package" sets of recommendations emanating from individual station-based research trials for adoption at the farm and command area levels, observation tours to visit relevant sites in other developing countries, and some training in use of the most modern available methodology, materials and equipment applicable to the more micro-oriented aspects at the irrigation minor and individual farm levels. Finally, the identified needs for equipment and U.S. scientists to help implement successful FORP efforts will be provided.

As noted above, additional specifics related to these three broad ICAR program support thrusts will be discussed under the following scientist exchanges, training, equipment and competitive grant sections of this design report.

2. Linkages to other India Water Management Programs

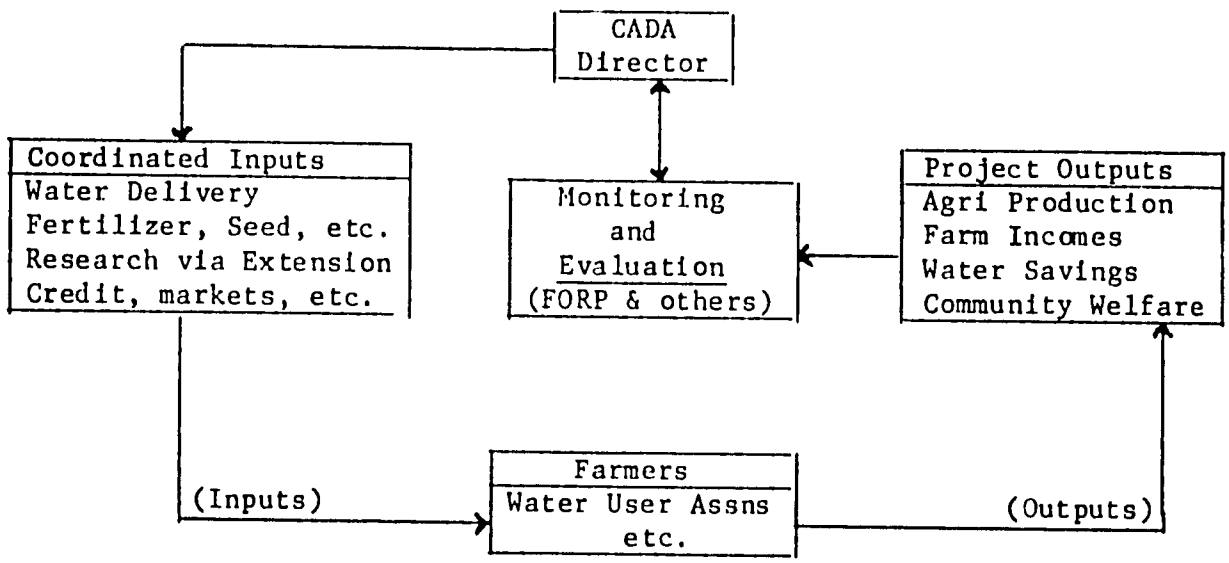
Identification of the kinds of desired linkages will necessarily remain a primary ICAR responsibility. Linkages to consider include those with other Indian governmental agencies involved in irrigation research and management, e.g. with other units within ICAR, the Irrigation Ministries, the Central Water Commission, CADAs, state-level Irrigation Departments, including irrigation research institutions, administrators in the various cooperating agricultural universities, Extension Service and other involved units in Departments of Agriculture, and the like.

There are two particular linkages in which USAID should have a vested interest in participating, however, because of its direct financial support: 1) a direct linkage between ICAR water management researchers and the WALMI effort; and 2) the linkage with the CADA and Irrigation Department administrators that both the WALMI and the FORP component of this ICAR oriented subproject will involve. Because the CADA linkage is common to both of these USAID supported efforts, it will be discussed first.

As we view the underlying reason for introducing the CADA mechanism into the irrigation management for major irrigation systems in India, we believe it came about primarily because of policy level recognition that providing a reliable flow of irrigation water is a necessary but not sufficient condition for insuring increased agricultural output from the irrigated agricultural sector. In other words, irrigated agriculture requires other inputs as well e.g. fertilizer, improved seeds, credit, adaptable research based technology and recommended practices via an Extension network, etc., and so CADAs were created to coordinate the availability to farmers of these necessary "input packages".

Specifically, the emergence of a CADA management unit approach was designed to address the need for improving the availability of all inputs, not just water. This, of course, is a great improvement over simply relying on Irrigation Departments' taking responsibility for only the irrigation delivery to the point of canal outlet, i.e. the CADA focuses directly on delivery of all inputs below the canal outlet. But a missing element, and one in which we think ICAR's FORP effort can have a vital role, is in providing CADA directors with an effective feedback mechanism as to what kinds and magnitudes of responses are occurring and why. This should take the form of a monitoring and evaluation function that operates continually so that delivery of inputs can be adjusted at the margin, so as to increase outputs. This emphasis on a continuous monitoring and evaluation "loop" in the system has been referred to in the scientific literature as "Management by Results" or "MBR" (Seckler and Nobe, 1984). The MBR approach has already been incorporated into the design and implementation of the new USAID/World Bank supported Command Water Management Project in Pakistan (Fairchild and Nobe, 1986). Schematically, this management framework is shown in Figure 1.

Figure 1 A Model for Incorporating an ICAR/FORP Monitoring and Evaluation Role in CADAs



Source: Adapted from the MBR model given in Seckler and Nobe (1984).

If this MBR function were to be included in ICAR's FORP effort in direct support of the CADA's, then the ICAR scientists involved would have two major functions: 1) delivery of one of the key inputs -- "adaptable" research based technology and practices, and 2) a monitoring and evaluation of outputs role (e.g. increased agricultural outputs and benefits, per objective (2) of the FORP effort). As a starting point, ICAR would need to have CADA and Irrigation Department administrative support for this function by ICAR scientists, and agreement as to its dual role via the FORP effort. This in turn would require firm memoranda of agreement.

In our view, a concerted effort should be made to establish at least one unit of the kind of institutional arrangement specified in Figure 1 to serve as a demonstration or "pilot" effort. Therefore, the design team feels that some assistance under this OFWM subproject should be devoted to this effort and it could be identified as one of the projects under the competitive grants program. Adoption of this recommendation implies, of course, that ICAR's involvement in its (on-site) FORP efforts should be long-term, say 10 or 15 years. Such time frames are considered necessary so as to fully affect changes leading to long-term, permanent increases in agricultural production, water savings and benefits to farmers operating under Indian socio-economic conditions.

Close coordination of this ICAR/USAID OFWM subproject with the USAID-funded Irrigation Management and Training (IM&T) Project would be mutually beneficial, particularly at the WALMI field-based - ICAR/FORP level. In both instances, these efforts are attempting to impact the CADAs and Irrigation Departments so as to increase agricultural output and project benefits by carrying out field-level research, monitoring and evaluation functions. For example, in Maharashtra State, the WALMI is carrying out a major field level program in the Pus Project area while the ICAR staff located at the Mahatma Pule Agricultural University is implementing a FORP effort on a minor in the Mula Project near Aurangabad, working with the local CADA. At present these two efforts are not linked, even though both have similar objecti·

Specifically, the IM&T effort at WALMI has an experienced, competent staff (mostly engineers but also some agronomists and economists) and access to a reserve of unused project funds earmarked for "action-oriented" research. Conversely, the ICAR/FORP effort at MPAU has access to a competent pool of agricultural researchers (mostly agronomists but also some agricultural engineers and economists) but will likely have only limited budget support from this OFWM subproject, relative to the level of effort that could usefully be developed during phase I. Close coordination would be desirable, however, because both groups have much to contribute to a joint effort.

Some ICAR scientists attending the recent workshop at Udaipur expressed concern that they are not adequately skilled to communicate with farmers and Extension personnel in their FORP study areas. Also, they are concerned that ICAR could unintentionally be expected to develop a major Extension function extending beyond their immediate FORP study areas, which would come at the expense of their primary research function. The selected field site areas for the FORP, however, do provide an ideal common ground for both ICAR scientists and Extension personnel who are attempting to assist farmers to increase their agricultural output. Therefore, consideration of a more direct linkage between ICAR's FORP efforts and Extension, so as to more adequately address the OFWM issues, would appear to be highly desirable.

Other linkages could also be implemented and/or strengthened, such as a direct linkage to the International Irrigation Management Institute (IIMI) in Sri Lanka and other similar international donor agency efforts (e.g. World Bank) but time and space constraints do not permit full evaluation of such ties in this subproject design report. ICAR/USAID administrators are advised to explore the feasibility of such linkages, however, as deemed desirable.

3. A Framework for Subproject Management

There are two components of the administration of the OFWM subproject that need to be recognized. First, there is the matter of administering ICAR's CPRWM (which now has given first priority focus to an OFWM component) and second, there is the administration of the proposed USAID-funded support effort via the proposed OFWM subproject.

Regarding the ICAR administration component, we have reviewed its proposed management/coordination format as set forth in its "On-Farm Water Management" proposal (ICAR 1985) and do not see any significant problems with their proposed approach. Furthermore, this component is primarily an ICAR responsibility in any case. One concern we do have, however, is that an effective linkage of the USAID-funded subproject to ICAR be set forth at the outset that is mutually acceptable to ICAR and USAID administrators.

As to administration and delivery of the USAID-funded OFWM subproject components, we assume that this "package" will be contracted to a U.S. supplying entity. Given the large short-term U.S./India scientist exchange component (to be discussed below), we recommend that the usual large, in-country technical assistance team not be considered for this subproject. Instead, we recommend a logistics unit in-country consisting of a half-time logistics person (e.g. Winrock International) and for the first two years a U.S. or Indian OFWM scientist (for coordination and training) to be located either in close proximity to the USAID/New Delhi office or wherever the ICAR Coordinator for the CPRWM will be located in the future. While effective coordination with ICAR would favor the latter, logistic considerations may require that the Delhi location be selected.

We also recommend inclusion of one scientist/support services position (Project Leader) at a U.S. based office of the subproject contractor, preferably at a university-based location. The function of this office would be to arrange for supplying the needed U.S. short-term scientific personnel, associated equipment, and support for in-country and U.S. based training and study tour facilities that are to be programmed by the in-country logistics office. Both in-country and U.S. based offices would require an appropriate level of clerical and operating budget support. The U.S.-based contractor's office should manage the budget for the manpower exchange, training and equipment components and be responsible for their time-sequenced delivery for the OFWM subproject support.

We would also offer recommendations as to the options available for selecting a U.S. contractor for this subproject. Generally speaking, these options include: 1) a private consulting firm, 2) one or more U.S. agricultural universities, or 3) a combination of 1) and 2). Our experience, having worked in and/or for both private consulting firms and universities, suggests that both private firms and universities have comparative advantages that could significantly affect the probabilities of success of the proposed OFWM subproject. For example, private consulting firms have generally demonstrated a comparative advantage in the logistics area (as have some university consortia) and normally can provide administrative services and related logistics personnel in-country on a long-term, continuous basis, that often extends for, say, the 5 year life of a project. Conversely, land grant universities in the U.S. house most of the available interdisciplinary OFWM-oriented expertise. We believe that universities are most likely to provide their best qualified personnel on a longer-term, recurring basis if scheduling thereof is under their jurisdiction, rather than being done by an independent private consulting firm employing such scientists as temporary direct hire consultants.

Given the above, and taking into account the research oriented nature of the proposed subproject, we strongly recommend that a direct U.S. university involvement be provided for in the contracting documentation. Given the likilihood of a large number of U.S. scientists being involved in recurring short-term visits to India and the relative comparative advantages of various U.S. universities for servicing visiting ICAR scientists, however, it would likely not be the best available option to grant the subproject contract to a single university.

Given the research-oriented nature of this subproject and the need for continuity of supplying a series of short-term U.S. scientists (housed primarily in universities) a sole private consulting firm contractor is not recommended either. Experience has shown that, far too often, private firms must resort to "targets of opportunity" when supplying U.S. agricultural scientists, who are not necessarily the best people available if a series of recurring visits to India by the same scientists is desired, as in this OFWM subproject.

This situation will likely become an even greater problem for USAID and private consulting firms in the future because U.S. university administrators are now moving towards further restricting the consulting options available to their faculties.

Subcontracting with a university consortium such as the Consortium for International Development (which includes 12 western states universities with most of the available university-based OFWM expertise in the U.S.) would be one option to consider. On the other hand, if involvement of a private U.S. consulting firm is desired (or mandated) by USAID (e.g. Winrock International), we would recommend consideration of a joint private firm/university (group or consortium) contractor for this particular OFWM subcontract.

B. Scientist Exchange Options

1. Indian Scientists to U.S. Program

Options for short-term work and/or study tours abroad by Indian ICAR scientists with OFWM subproject support would generally fall under one of the following categories: a) a short-term orientation tour for senior administrators/scientists; b) mid-term research/study tours for career scientists; and c) tours as appropriate under the proposed competitive grants component. These categories will be discussed in this section while related short-term training will be dealt with separately in Section III-C below. While the majority of work or study abroad will be in the U.S.A., some participants activity could take place at non-U.S. institutions, for example at one or more international research center locations, while enroute to and from the U.S.

a) Short Term Orientation Tour for Senior Administrators/Scientists

This component would be a specially designed orientation/study tour of 3-4 weeks duration for five senior ICAR OFWM administrators/scientists at the earliest possible date after activation of the OFWM subproject. If possible, this tour would be scheduled so as to include management seminars and/or brief workshops. The participants would also be scheduled to spend some time observing the management of relevant U.S. agencies or other institutions. Examples might include visits to U.S.Department of Agriculture laboratories, U.S. Bureau of Reclamation offices, and the Salt River Project. The primary purpose of the early U.S. visit of this advance team of ICAR personnel would be to identify and interact with senior U.S. irrigation management scientists to be involved in the OFWM subproject, to be followed by their return TDY visits for joint development and initial implementation of the OFWM subproject work plan in-country.

b) Career Scientists Fellowships in the U.S.

This component would be primarily for Indian scientists actively engaged in ICAR research. Participants might be relatively recent graduates (probably but not necessarily Ph.Ds) going for further training or experience in specialized areas, and/or mid-career scientists interested in broadening or upgrading their skills by working with U.S. scientists. These would be non-degree programs, usually post-doctoral, and generally of 6 to 10 month duration. These could include course work, research, or both. Funds would be provided for university fees, tuition if course work is involved and a small amount of research support. Some additional travel support could also be provided for attendance of professional meetings and visiting other research locations in the U.S. or elsewhere enroute to and from the U.S.

Examples of the types of program elements that might be involved include work in irrigation scheduling modelling, modelling and design of irrigation and drainage systems, crop response modelling, stress physiology, design and analysis of experiments, and micro-economic studies appropriate to the FORP. We are currently projecting that up to 25 scientists would participate in this program, of which 15 would be designated by ICAR in the early stages, while 10 would be initially reserved for scientists working on research projects coming under the competitive grants component (see Section III-B-2-b and III-E).

c. Competitive Grants - Study Tours

One of the goals of the competitive grants component is to stimulate the further development of ideas for new and relevant research as put forth by ICAR scientists. Some of these may require the development of particular skills, specialized training, etc. not available in India. In some cases the post-doctoral U.S. study tours for career scientists mentioned above may be appropriate for recipients of the competitive grants projects, and for this reason it is suggested above that 10 such tours be initially reserved for this purpose. However, some other projects could require somewhat different types of programs abroad. Under this component, virtually any type of program appropriate to a selected research project would be considered, if identified as a high ICAR priority.

2. U.S. Scientists Visits to India

It is important to emphasize here that the contract management entity to be selected for this subproject must have the capability to access the top U.S. scientists available in the irrigation management field. Some of these scientists may be working in U.S. government agencies and/or the private sector but most of them who would be available on a recurring basis are located at various land grant universities. Selection of areas of expertise which are needed and/or identification of individual scientists might come about in a number of ways including the setting of priority areas by ICAR, the competitive grant program needs, and the selection of trainees for workshops and short courses to be held in India.

a. ICAR Priority Areas

A portion of the funding would be set aside for providing U.S. scientists to work with ICAR on specific in-country projects in priority areas. Such U.S. scientist participation would be on a recurring, short-term basis, i.e. the scientist may come to India two or three times over the life of the subproject. Priority areas would be set by ICAR. ICAR may either request specific scientists or simply ask for specific areas of expertise. Subproject management personnel in the U.S. would attempt to access specific individuals, as requested by ICAR, or if they are not available, would locate and/or suggest reasonable alternatives for ICAR consideration. Participating U.S. scientists may also have Indian scientists working with them in the U.S. under the career scientists fellowship program described under III-B-1 above. Tentatively, funding for 40 U.S. scientist months are projected in this category.

b. Competitive Grant Cooperating U.S. Scientists

There is no essential difference in this third category and that described above except that the U.S. scientist may be requested, either by name or by area of expertise, under the competitive grants program. Indian scientists would be encouraged to develop their proposals in cooperation with appropriate U.S. scientists. For initial budgeting purposes, we have assumed 21 scientist months in this category over the life of phase I of this subproject.

c. Workshop and Short Course Trainers

We have projected that several workshops and/or short courses on specific topics will be held in India. A high priority example is one on micro-computer applications. The workshops/short courses would be jointly conducted by Indian and U.S. trainers (see Section III-C below). Some preparation time prior to arrival in India is appropriate for U.S. scientists involved in this program. A total of 12 months of U.S. trainer time in India plus 12 months of course development and preparation time in the U.S. are projected in this category.

3. Graduate Student Exchanges

We do not recommend the sending of Indian scientists to the U.S.A. to obtain graduate degrees under this subproject. We feel that in most disciplines relevant to OFWM research, Indian agricultural universities are basically adequate for most degree programs up to and including the Ph.D. There are, however, technical areas within which this training could be substantially strengthened by including some formal course work done in a U.S. university. We, therefore, recommend that the OFWM subproject include a component whereby a limited number of Indian graduate students already involved in ICAR OFWM research would spend up to one year at an appropriate institution in the U.S. as part of their Indian university degree program.

Some institutional problems may need to be addressed in relation to this program, but these should not be insurmountable. As, the subproject is specifically designed to assist ICAR in attaining certain goals, ICAR may wish to limit participation to students who have a definite responsibility to ICAR, such as staff members on study leave to obtain advanced degrees. Secondly, assurance would have to be obtained from the concerned Indian university that work done at the U.S. institution would apply toward the Indian degree.

In order to foster long term interest in scientific exchange, we further recommend a limited program component whereby U.S. graduate students could do atleast part of their thesis or dissertation research (perhaps upto one year), at an Indian institution. Again careful attention must be given to the need for the work done to make a solid contribution towards the subproject goals. Selection of students with prior experience would be preferred, and a work plan formulated that is consistent with ICAR objectives and that can be accomplished within available resources. They could perform a junior scientist (i.e. research associate) function within an ICAR related program, particularly when done in support of an OFRP component. One option might be to have these persons temporarily replace ICAR saff while they are in the U.S. under the scientist exchange program component. The thesis or dissertation and any resulting publications would be part of the output of the OFWM subproject. Stipends for the time that the U.S. students are in India and associated travel costs would be borne by the subproject.

We project that 20 Indian and 10 U.S. students would participate in the graduate student exchange program over the phase I life of the subproject. Finally, it is worth noting that inclusion of this student exchange option was strongly supported by Indian university administrators, including two vice chancellors, with whom we have discussed this matter.

C. Short-Term Training Components

Short-term training options would include both training conducted in India, such as special applications workshops/short courses, and special short-term study tours to visit field sites in India and/or other countries where relevant work is underway. Attention in this regard should be given to special training for FORP teams, as many of the activities carried out in these efforts are outside the normal areas of research expertise of the individuals assigned. These may or may not involve visits to the U.S. Relevant short courses that may be available at international research centers would also be very applicable here. It may also be possible that a formal linkage with the IIMI could be developed for short term FORP training and/or for conducting study tours to countries where similar projects are in progress. Three short term training components would be included, as follows:

1. Applications Workshops and Short Courses

These have been discussed briefly above in relation to U.S. scientists' participation as trainers. For each workshop planned, one or more Indian scientists would be selected as co-trainers. These Indian trainers would spend 1-2 months in the U.S., working with the U.S. trainers in the preparation of training materials. The Indian and U.S. scientists would then jointly present the first offering of the workshop in India. (Subsequent offerings, as needed, might or might not involve U.S. trainers.) A general micro-computer applications workshop is our first priority area.

Other applications workshops and/or short courses that would be more subject matter oriented but still utilize computer applications as a common theme could include the following: a) Drainage Design and Management; b) Design and Management of Irrigation Systems (both conventional surface irrigation systems and drip irrigation techniques); c) Micro-economic Methods and Applications; and d) Experimental Design and Application. A short course in Extension Delivery Methods could also be considered. For developing the budget estimate for this component (see Section V), we have assumed that six such workshops/short courses would be developed and offered. More or less than this number could be considered, however, depending on how ICAR decides to utilize the U.S. visiting scientists component in this subproject.

2. FORP Team Training

Many of the elements to be involved in training FORP interdisciplinary teams are already included in various existing workshops and short courses currently being offered in the U.S. Applicable training components are also emerging in the WALMIs, such as the Diagnostic Analysis Short Course recently presented at WALMI/Aurangabad. It is our recommendation, however, that a short-course tailormade for the FORP participants, be developed and offered jointly by

U.S. and Indian trainers drawn from the above mentioned relevant training programs. Further, we recommend that this short course be offered in India at one or more WALMI locations, perhaps with WALMI/ICAR cost sharing, so as to further cement the linkage between these two USAID-funded projects.

3. Related Opportunities for Visiting ICAR Scientists in the U.S.

Over and above specifically designed workshops and short courses to be offered in India, examples of which are listed above, there will be a number of opportunities for the Indian scientists involved in the scientist exchange program to participate in relevant workshops and short-courses currently being offered by various U.S. universities. While such offerings will be less India oriented than the above listed specifically designed courses, many with which we are familiar do include India examples and applications. Further, they offer the opportunity for the Indian participants to interact with the participants from other countries and thus learn from each other how irrigation research and management issues are being dealt with in other developing countries.

D. Equipment Support

1. Rationale

In the formulation of our strategies and recommended funding levels for equipment support, we have taken into account (a) our perceptions of need as derived from our own observations and from discussions with ICAR administrators and research scientists, (b) the equipment list provided as Appendix I in the ICAR (1985) program request document, and (c) resource limitations, i.e. money used for equipment obviously reduces the amount available for other subproject components. The total amount that we recommend for equipment purchase is about US$ 1.3M, which is really quite modest, considering the size of the ICAR OFWM research effort. Undoubtedly, additional funding could be effectively used for this purpose, but, given probable subproject budget constraints, we do not feel that we can recommend a higher level and still effectively meet other projected program needs.

The 1985 dated list provided by ICAR would procure a variety of both basic field and laboratory equipment and specialized, and in some cases highly sophisticated, research equipment at a total cost of about US$ 1.7 M. ICAR proposed that this equipment would be procured primarily for use at three locations, i.e., WTC/New Delhi, WTC/Eastern region, and the Project Directorate for Water Management. Little provision was made for equipment at other ICAR locations, equipment to meet the needs of the FORP projects, nor for badly needed computing/data processing equipment.

Accordingly, we are recommending three separate categories of research equipment support: 1) computers and other data processing/management equipment, 2) basic field and laboratory equipment; and 3) specialized research equipment. Each of these categories would be handled somewhat differently in regards to priority, procurement scheduling, and distribution among the various research locations. Therefore, they are discussed separately below.

2. Computing/Data Processing Equipment

We recommend the procurement of 60 desk-top microcomputers. While capability and price of this equipment has historically changed rapidly, at present we would suggest machines equipped with one 5-1/4" floppy disk, one 20 megabyte hard disk, a minimum of 512 K memory, graphics capability, monitors and printers. This is the approximate configuration of the current IBM XT Model package but similar capability is available from a variety of manufacturers that are IBM compatible. One 132 column near letter quality dot matrix printer should be procured for each computer.

Compatibility with the MS DOS operating system is a must in order to effectively utilize the wide variety of U.S. software available for both general research applications and specialized software which has either been developed for or adapted to water management research applications. We understand that equipment of this type may soon be available from at least one Indian manufacturer, so that a local purchase option may be viable. Such a local purchase option should only be considered, however, after careful testing and evaluation to insure software compatability, and if timely delivery and maintenance schedules can be assured.

Similarly, rigid procurement conditions should be imposed for the U.S. purchase option. An absolute condition should be made that any machine brand considered should be actively marketed in India and that service facilities are available and reliable. We note, for example, that the Tandy 2000 is locally available. Furthermore, machines should operate on the local electrical current and be protected against voltage fluctuations.

Micro-computers should be procured immediately on the availability of subproject funds. At least 25 machines should temporarily be installed at a central location where they would be utilized for computer application workshops/short courses. The remainder would be distributed to the various research locations. After all application workshops have been completed, the machines utilized for this purpose would also be distributed, as needed. For example, some of the competitive grant recipients may specify a micro-computer need in their proposals.

We also recommend the procurement of one somewhat more sophisticated system for installation at the OFWM Project Directorate. This system would be utilized for assembling and maintaining a common data base, consisting of climatic data and results of the various field experiments conducted under the OFWM program plus any other appropriate data sources available. Among other uses, this data base would be particularly valuable for aggregation and sysnthesis of OFWM research results, and for various types of modelling. We do not have information readily available to provide detailed specifications for this installation. At a minimum, however, the system should have one or more machines of capability similar to the IBM AT model, or perhaps one of the smaller VAX models. Capability to transfer information from this machine to the smaller XT type units discussed above, either by direct linkage or by the transfer of files to XT readable floppies will be necessary.

Estimated Costs:

Desk top micro including 1 5-1/4" floppy disk drive, 1 20 megabyte hard disk, graphics and monitors @	$ 2,500	
132 column NLC dot matrix printer	500	
Software and accessories	1,000	
	$4,000 per unit	
60 units @ $4,000		$240,000
Special Installation for OFWM PDWM		60,000
Total Computing Components		**$300,000**

3. Basic Field and Laboratory Equipment

Included in this category are basic items of equipment that are utilized for a variety of research projects at many ICAR locations involved with soil-plant water research. Examples include such things as field sampling equipment, pressure membrane extractors and accessories, tensiometers, environmental monitors, colorimeters etc. It is entirely appropriate that USAID OFWM subproject funding be used for procurement of such equipment. The list furnished by ICAR contained many such items. Some examples have been extracted and included in Table 1, although in some cases the numbers to be procured have been modified. However, the data in Table 1 should only be regarded as examples of the types of equipment to be procured in this category, rather than as the actual list to be procured. The reason for this is that the ICAR list is nearly two years old at this writing, and perceived needs, priorities, and costs do

change with time. For example, ICAR should now provide some equipment in this category for other non-WTC locations, and particularly for FORP efforts. We recommend that when funding becomes available, ICAR present a revised list of items in this category, within the total budget level allotted for this category. Procurement can then be initiated. We recommend a total of about $500,000 be allotted for this category.

Table 1

Examples of Items Appropriate to the Basic Field and Laboratory Equipment Category. (Extracted from ICAR 1985 list and modified)

Item No.	ICAR Item No.	Description	Numbers to be procured	Total Cost U.S.$
1.	1 a.	Current meters - large	6	7,500
2.	1 b.	Current meters - small	6	4,000
3.	2 a.	Water Meter (saddle) 15 cm	12	3,000
4.	2 b.	Water Meter (saddle) 10 cm	12	2,500
5.	3	Water Stage Recorder	24	10,000
6.	5	Neutron Moisture Meter	3	37,200
7.	6	Tensiometers with spare cups	150	7,500
8.	7	Moisture Meters (electrical resist)	6	6,000
9.	8	Pressure Membrane Extraction	2	4,000
10.	9	Ceramic Plate Extractor (15 bar)	2	3,000
11.	10	Ceramic Plate Extractor	2	2,000
12.	11-13	Spares and accessories for extractors		2,600
13.	14	Air compressors 300 psi	3	4,000
14.	15	Manifold for extractors	3	3,000
15.	16	Pressure Bomb with accessories	3	9,000
16.	19	Soil Psychrometers	150	4,000
17.	20	Sample Chambers for leaf water R.I	60	4,500
18.	21	Dew Point Micro-volt meter	3	6,000
19.	22	Psychrometer switch box	3	1,500
20.	27	Core sampler w/accessories	6	1,250
21.	28	Soil sampling tubes, 4'	18	2,250
22.	29	Soil sampling tubes, 6'	6	1,840
23.	30	Drop hammer for sampling tubes	18	1,800

Item No.	ICAR Item No.	Description	Numbers to be procured	Total Cost U.S.$
24.	31	Puller jacks for sampling tubes	18	6,750
25.	32	Soil salinity sensors	150	9,000
26.	23	Salinity bridge w/accessories	3	4,000
27.	36	Environmental monitoring system	3	30,000
28.	42	Photographic equip incl. color proc.	3 sets	60,000
29.	46	Atomic absorption spectrophotometer	3	50,000
30.	48	Digital flame photometer	3	15,000
31.	49	Digital colorimeter	3	5,000
32.	50	Electrical top pan balance	9	9,000
33.	52	12 channel millivolt potentiometric recorders	3	45,000
34.	53	Portable potentiometers	6	15,000
35.	54	Solarimeter w/recorder-integrator	3	30,000
36.	55	Anemograph w/recorder	3	7,500
37.	56	Soil thermographs	18	9,000
38.	57	Net radiometers	6	6,000
39.	58	Foot candle meters	6	6,000
40.	59	Portable pyranometers (Epply)	6	12,000
41.	60	Albedometers	6	6,000
42.	61	Sunshine duration recorders	3	5,250
43.	62	Actinograph	3	9,000
		TOTAL BUDGET		467,940

4. Specialized and Project Oriented Equipment

Many of the more sophisticated and expensive pieces of research equipment available in the market tend to be utilized largely by a few specific types of research projects. Furthermore, such equipment often requires specialized expertise for installation, operation, and maintenance. The 1985 ICAR list includes many examples of such equipment, such as precision electromechanical weighing lysimeters, reflectance radiometers, recording spectrophotometers, leaf area meters, nitrogen analyzers, etc. Again, within available resources, it is entirely appropriate to utilize subproject funds for procurement of such equipment. However, we recommend that they be identified on a research project basis, rather than to procure a set for selected ICAR locations and assume it will be utilized at some future date. The latter approach often results in equipment being under-utilized and it then often deteriorates for lack of maintenance.

We suggest that procurement of such equipment be undertaken only to service approved research projects where it is required and where personnel qualified to install, operate, and maintain it are either available at the location, or there is reasonable assurance that such staff will be available when the equipment arrives. This approach will tend to maximize utilization of scarce equipment resources and encourage the initiation of projects utilizing such equipment by qualified researchers. The availability of funds to obtain specialized project equipment would fit well with the competitive grants program that we are proposing. Therefore, we recommend that 40 to 50 per cent of the funds allocated in this category be reserved for competitive grants. The total funding level recommended for specialized equipment, on a project basis, is about $500,000.

E. A Competitive Grants Proposal

While various components of USAID-funded support to the OFWM effort have been discussed above under conventional headings, (e.g. dealing with ICAR scientists study tours and fellowships, training options, U.S. scientists visits to India and equipment), there is also the option of combining these elements, in part, in a series of special projects under a competitive grants program. Specifically, we recommend that some portion of the subproject resources, say, 40 to 50 percent, be allocated to a program to support special project proposals. There are two major reasons for this recommendation. First, effective research evolves and flourishes best if some opportunity is given for individuals and/or teams of researchers to pursue innovative research ideas not yet a part of the conventional research format. Second, progress on such relatively small components can be more easily monitored for progress and performance by USAID and ICAR than can the progress and performance by the total USAID support effort envisioned under this subproject.

A number of examples could be given of the type of project proposals that could be considered in a grants program, but we will cite only two cases which came to our attention during our field visits. One of these is a proposal submitted to the World Bank by the ICAR team at the Agricultural College and Research Institute at the TNAU Campus at Madurai, entitled "Proposal for Organizational Research Project on Rice and Sugarcane in Periyar-Vaigai Command Area". This proposal essentially would expand the present FORP study area from its present 40 acres to an area of about 1,000 acres and would also extend its duration for another five years. A copy of this proposal is included as Appendix Item 2.

The other proposal that came to our attention was one submitted by Dr. V. Rajagopalan, Vice Chancellor, and Dr. S. Krishnamoorthy, Associate Professor of Agricultural Economics, at Tamil Nadu Agricultural University, Coimbatore, entitled "Conjunctive Use of Ground Water and Surface Water for Optimal Irrigation Management and Cropping Pattern in River Basin Projects under Different Rainfall Situation" (Appendix Item 3). As we understand it, this is one of four such conjunctive use studies in four different parts of India that have already been sanctioned by ICAR. We see no reason, however, why such study proposals could not be funded in part (e.g. U.S. study tours, U.S. scientists visits and equipment) by the USAID OFWM subproject under a competitive grants component.

So as to insure a sense of unbiased selection of successful proposal recipients, we recommend the establishment of a Proposal Review Committee to establish evaluation criteria and assist in the initial screening of proposals. Membership ideally would include representation from the ICAR Project Directorate, the Irrigation Unit in the USAID/New Delhi Mission and from the subproject contractor's office. In order to insure that ICAR priority issues were being met, however, ICAR should have ultimate selection authority.

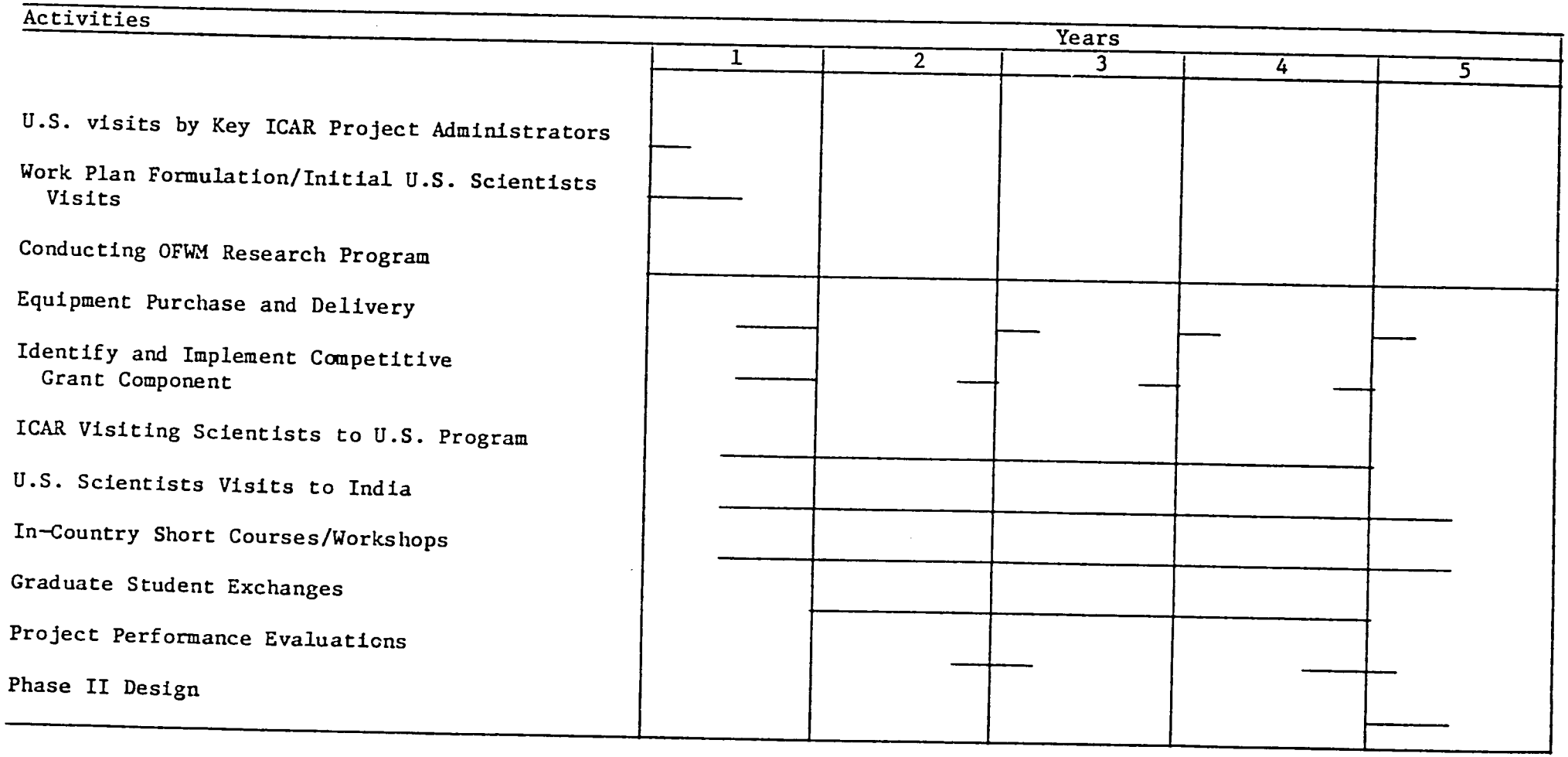
IV. PROGRAM IMPLEMENTATION

Ten major activities have been identified for implementation and/or support under the proposed USAID OFWM subproject. These are: 1) Workplan formulation, involving initial exchange visits by key ICAR project administrators/scientists and senior U.S. scientists; 2) Conducting the on-going ICAR OFWM research program, with U.S. technical assistance; 3) Equipment purchase and delivery; 4) Identification and implementation of competitive grant components; 5) ICAR visiting scientists to U.S. program; 6) U.S. scientists visits to India; 7) In-country short-courses and workshops; 8) Graduate student exchanges; 9) Project performance evaluations; and 10) Phase II design. These activities are shown in a time-frame sequence in Figure 2 and discussed individually in the following sections of this report.

A. Work Plan Formulation and Initial Scientist Exchange Visits

While broad areas of emphasis for USAID's subproject support for the ICAR's ongoing OFWM research program have been identified in a previous section of this report, these elements remain to be integrated into an overall work plan for this effort. We propose that the initial work plan be developed jointly by key ICAR administrators/scientists and U.S. scientists to be identified as early as possible after project implementation. In order to accomplish this, we propose that a team of five key ICAR administrators/scientists responsible for the OFWM project would make a three to four week orientation visit to the U.S. to interact with irrigation management scientists at selected universities and U.S. agency research stations.

Figure 2 Scheduling of Major OFWM Subproject Activities



The membership on this advance ICAR team would be established by ICAR but we recommend that, collectively, the four major disciplines involved in the research effort -- soil scientist, crop specialist, agricultural engineer and social scientist (i.e. economist) -- be represented so that the in-country technical services and support for later longer-term study tours for ICAR scientists in the U.S. can be fully evaluated. The itinerary for this ICAR advance team visit would be coordinated by the contractor's U.S. based project leader who would accompany the advance team during the U.S. portion of the trip.

During the ICAR team's visit, a team of five U.S. scientists to be associated with this effort for the life of the subproject would be firmed up. The primary function of the U.S. team would be to coordinate USAID subproject support activities. It would include representation of the four major discipline areas identified above and one of these would also serve as the contractor's U.S.-based project leader. The fifth member of the contractor's Coordinating Team would be the scientist/ coordinator to be stationed in India at subproject headquarters for the first two years (or an Indian scientist/coordinator if placing the U.S. in-country person is not viable).

Shortly after the ICAR advance team returns to India, the U.S. Coordinating Team would make an initial visit to India for three to four weeks to work with the ICAR advance team to firm up the plan of work and to initiate subproject activities. Field visits to selected ICAR stations and FORP sites would be made at that time.

Other tasks to be accomplished during this return visit to India would be: 1) To finalize the equipment component (except for that portion to be tied to the competitive grant program) and to arrange for orderly delivery; 2) Establish the procedures for operationalizing the competitive grant program; 3) Identify the initial group of ICAR and U.S. scientists to be involved in the scientist exchange program; and 4) working with key administrators from ICAR and the cooperating Indian universities, establish procedures for conducting the graduate student exchange program. Ideally, the return U.S. coordinating team visit should be accomplished during the first three months of the subproject but a six month period is provided for (see Figure 2) to allow for any scheduling difficulties that may arise.

B. Conducting OFWM Research Program

The OFWM research program is, of course, an on-going ICAR effort and as such will remain under its direct administrative supervision. Initial interaction with the USAID subproject will be through the contractor's in-country logistics person and the U.S. or Indian scientist/coordinator. But, as the scientist exchange program is implemented, there will likely also be periodic but continuing in-country interaction by U.S. scientists and by a limited number of U.S. graduate

student research associates stationed in-country for their dissertation research. Specific activities of the visiting U.S. scientists will be programmed in the initial plan of work and periodic updating thereof but will generally consist of a mix of joint research/efforts and participating as trainers in in-country workshops and short courses.

C. Equipment Selection and Delivery

Equipment to be provided by the subproject had been categorized in the previous sections as consisting of three types: 1) Computing/data processing equipment; 2) Basic equipment and 2) Specialized equipment. It is anticipated that the basic equipment will be delivered by the end of year one while the specialized equipment delivery schedule will be dictated by the nature of the projects to be identified periodically throughout the life of the project, either directly by ICAR and/or under the competitive grants program.

D. Identifying and Implementing the Competitive Grant Component

The activation of individual research projects to be supported by the competitive grant component cannot be fully programmed in advance. While an initial group of grant recipients can perhaps be identified early during the subproject period, say, during the last six months of year one, the remainder will likely be identified in two or more additional groups after individual Indian scientists return from their 6-10 month U.S. study tours. It is anticipated that many of these scientists will develop research proposals while in the U.S., working in collaboration with selected U.S., scientists and may also involve following U.S. scientists return visits to work with them on these projects in India, particularly during the implementation phases. Since the ICAR scientists who spend study tours in the U.S. will be exposed to the latest sophisticated equipment and methodology available, it is for this reason that we recommend that part of the sophisticated component of the equipment category be tied to the competitive grants program.

E. Visiting ICAR Scientists to the U.S. Program

The period of time programmed for this segment is from mid-point in year one to the end of the fourth year. Since the selection of individual participants is an ICAR responsibility, the time and sequence cannot be determined in advance. It is anticipated, however, that most of the activity will occur early in the program period but certainly ICAR will have to balance the absences of some of its key OFWM scientists with the need for maintaining momentum in its on-going research program.

It is not anticipated that the flow of these scientists to the U.S. will overload accomodation capacity at that end, particularly since the participants will likely distribute among several U.S. site locations.

The U.S. contractor, of course, will have responsibility for coordinating these locations with the participating institutions, accommodating to the degree possible the preferred locations identified by ICAR.

F. U.S. Scientists Visits to India

Scheduling the sequence and timing of the U.S. scientists to be involved will largely depend on the ICAR requirements for such technical support. Some requests may entail a one-time visit, for example, to participate in a particular seminar or workshop. We do anticipate, however, that for most scientists, their involvement will consist of several short-term visits each. This would be true in particular for the scientists constituting the U.S. Coordination Team but would also likely to be the case where approved projects in the competitive grants program involve U.S. counterparts. We have scheduled the U.S. scientists visits for the life of the project so as to allow maximum flexibility.

G. In-Country Short-Courses and Workshops

While this activity is also programmed for almost the total life of subproject, we expect that most of this activity will occur during the first half of Phase I. Coordinating and participating in this training component would be one of the functions of the U.S. scientists programmed to be located in India for the first two years of the subproject if the U.S. option is selected. This expectation is based on the fact that in-country training can be programmed to start at an early date and because as follow-up offerings of many of the short-courses are scheduled (say, after two years) the trainer function can shift from the initial joint U.S./ICAR effort to a total ICAR function. Since these short-courses will involve a number of U.S. university faculty, at least initially, who also have other on-campus duties in the U.S., it will be critical to schedule the timing of individual short courses in India as far in advance as possible. Since most universities operate on a semester system, at least six months advance notice to a university administrator requesting release of a faculty member will be needed so that the faculty member's on-campus teaching and/or research/Extension duties can be rescheduled -- and a 9-12 month notice would be even more desirable. Therefore, preparation of the initial plan of work, and annual updating thereof, must specify time frames for workshops and short courses to be conducted in the subsequent time period.

H. Graduate Student Exchange/Program

Since the ground rules for this program will likely take some time to negotiate with cooperating university administrators, both in India and the U.S., we have not programmed this activity to start until year two. Further, to insure that all participants to be involved in the system will have completed the exchange portion of their graduate degree work by the end of Phase I, we have not scheduled any new entries in the last year of this phase of the subproject.

I. Project Performance Evaluations

As is routine with USAID-funded projects of this type, we expect that year to year progress and performance evaluation mechanisms will be agreed upon during the initial work plan development phase. We do recommend, however, that a formal mid-project external evaluation and another formal external evaluation near the end of Phase I be scheduled. The first evaluation review would provide a basis for a mid-program redirection if rates of progress and/or presently unforeseen developments would so dictate. The evaluation near the end of phase I would provide a frame of reference for the design of phase II.

J. Phase II Design

It is our strong recommendation that USAID support for ICAR's OFWM research program be viewed as a long-term proposition. Earlier, we have noted that, in particular, ICAR's FORP effort in selected command area locations should continue for 10 to 15 years because the time lag in achieving significant crop yield increases in irrigated command areas and in farm incomes will so dictate. India's future agricultural production increases will have to heavily depend on adoption of improved, research based technology and practices at the farm and command area levels. Therefore, USAID's continued support for ICAR's OFWM program merits a high priority but also one which will likely generate significant long-term benefits -- the flow of which will just barely be underway by the end of Phase I.

Many development processes being supported by USAID do not lend themselves to achieving project objectives within the typical 5-year time frame and this subproject is certainly one of them. The severe budget constraint envisioned for this Phase I effort may further constrain the rate of progress that can be achieved in regard to subproject objectives during this time frame. Therefore, in order to insure continuity (without a time gap) between Phases I and II, we have programmed the Phase II design activity to occur in the first half of year five.

V. FINANCIAL PLAN

A. Basic Considerations for Subproject Agreements

Agreement between ICAR and USAID, relative to their respective inputs to the OFWM subproject, will be necessary and, to the extent possible, should be spelled out as formal conditions. On the other hand, such conditions should not be overly constraining to ICAR's on-going effort and must be realistic, relative to the Indian Central and State Government regulations under which ICAR must operate. We recommend due consideration of the following conditions for ICAR actions and agreements:

1. Demonstrated best faith efforts by ICAR (subject to state level restrictions) to obtain position sanctions, funding for and filling at least one position in each of the major disciplines involved in the OFWM effort (e.g. soil scientist, crop scientist, agricultural engineer, economist and/or sociologist) at each of the 34 centres engaged in this program.

2. Obtaining formal memoranda of agreement with the CADA or Irrigation Department district in which the field site(s) is to be located for specific FORP efforts (as might emanate from the competitive grants component). Elements to be included are:

   a. Specific role that the FORP is to carry out and where it links into the CADA or Irrigation Department administrative framework.

   b. Duration.(We recommend 10-15 years in any given location).

   c. Support level and type of facilities and/or equipment to be provided to support the FORP effort by both parties to the agreement.

   d. Specifics in regard to interaction with the Extension Service and/or other state level entities to be involved.

3. Written agreements regarding the manner in which enrollment in a U.S. university for formal courses by Indian students funded under this subproject will be accepted for meeting degree requirements by the India degree granting institutions. (Institution by institution agreements are preferable to student by student agreements.)

4. Similar agreements with U.S. universities involved would be needed before subproject funding would be released to fund U.S. student research efforts in India.

5. A statement of intent, subject to satisfactory performance levels during Phase I, that ICAR and USAID would expect to follow-on with a Phase II, subproject component (with additional add-on periods possible

so as to recognize the long-term time frame in which increased crop yields and farmer benefits can reasonably be expected to expand under developing country conditions such as found in India).

B. Budget Summary

We have estimated a total phase I budget level of $5.90M, net of inflation. The estimated budget level, by major categories, is given in table 2. These data reflect our best estimates as to the total level of effort that could be sustained under USAID's proposed OFWM subproject during the Phase I, 5-year time frame. The actual level of effort that can be carried out, of course, will be constrained by the maximum budget level USAID has available for this subproject during this time period. Unfortunately, attempts to operate at a substantially reduced level of funding would result in a significant reduction of effectiveness per unit of input, due to dilution of effort, i.e. a lack of "critical mass". If it is absolutely essential to operate at a budget level for this subproject that is less than that identified in Table 2, options to consider for supplemental funding range from joint funding with related projects to delaying parts of some components to Phase II. (see section V-C below).

We call particular attention, however, to the price tag for subproject administration and delivery by a U.S. contracting entity (Item 1, and the U.S. scientist in-country for the first two years table 2). These administrative/and coordination costs could not be significantly reduced, even if the funding for the other budget areas were substantially reduced. (one additional option that could be considered, would be to replace the budgeted U.S. scientist in-country with an Indian scientist that would reduce costs somewhat). These line items represent indivisable "sunk costs" for operating the subproject while the level of funding for the delivery of the remaining divisable components represent "variable costs". The lower the ratio of sunk costs to variable costs, the more cost effective this OFWM subproject would be.

Table 2 below provides a budget summary. Separate budget tables (tables 3a-f) for each major component and a summary of scientists months of funding for ICAR and U.S. scientists (table 4) are given at the end of Section V.

Table 2 - Budget Summary

Program Element	Amount
Contract to U.S. Project Entity (Subproject Administrator)	1,321,461
Scientist Exchange Program	
Indian scientists visits to U.S.	704,450
U.S. scientists visits to India	1,653,499
Graduate Student Exchange Program	770,600
FORP staff training and orientation tours	150,000
Equipment Support	1,300,000
Total Estimated Base Subproject Cost	5,900,010
Inflation Factor (12%)	708,001
Total Adjusted Project Cost	6,608,011

C. Linkages and Phasing Options

If the $ 5.90 M projected base budget level (net of inflation) for the proposed OFWM subproject cannot be made available under the parent Agricultural Research Project during the phase I time frame, we recommend that serious consideration be given to making a formal linkage to the on-going IM&T project. There are several areas of strong mutual interests and objectives between these two projects. These include: 1) Both projects have major training components directed to OFWM; 2) Both projects are operating (and hope to expand) FORP efforts in irrigation command areas; 3) A formal linkage to the Extension Service role is inherent in both project efforts; 4) The convenents in the IM&T project paper envisioned linkage with agricultural university based researchers (USAID, 1983) and the ICAR effort also has this linkage; and 5) The WALMI's hope to expand their station type and "action" research facilities, and the IM&T project has earmarked funds for such research, while ICAR programs at cooperating agricultural universities have the capability to deliver manpower to service it. Given the above, we believe there is ample evidence that both of these USAID assisted projects would benefit from establishing a formal linkage.

Another linkage option worth exploring would be with the relatively new IIMI program. Portions of the manpower improvement component, particularly the training for the scientists engaged in the FORP effort, could benefit from observation tours arranged under IIMI auspices to relevant projects in other countries in Southeast Asia in which IIMI has programs underway, e.g. in Sri Lanka, Indonesia, and Pakistan. It may well be possible that IIMI would agree to fund those study tours directly and/or provide direct funding for some of ICAR's OFWM research efforts in India. If either or both efforts could be partially funded by IIMI, then a potential short-fall in USAID budgetary support for the OFWM subproject could be substantially offset.

Given, the World Bank's substantial involvement in several command areas in which ICAR is operating FORP projects, consideration should be given to determining whether the Bank would be willing to fund part of ICAR's FORP efforts and related equipment needs as a joint effort. While the Bank's earlier efforts have been directed primarily to extending structural measures to smaller chaks, its administrators have developed some joint OFWM efforts, with USAID; i.e. in the Command Water Management Project in Pakistan and the Gujarat Medium Irrigation Project in India. It is apparent that a potential now exists in India for further joint USAID/World Bank cooperation in OFWM efforts, based on discussions with, and an OFWM program summary provided by, T.S. Bredero of the Bank's New Delhi office (See Appendix, Item 4).

If no options for joint funding can be developed in the short run, then, of course, it would be necessary to down-fund some of the proposed OFWM activities during Phase I by extending the delivery periods into Phase II. The areas in which this would most likely occur, would be in the manpower development and U.S. scientists components because ICAR had previously indicated a high priority preference for the equipment component. This alternative would be at great cost to project effectiveness, however, because "critical mass" in meeting the institutional capacity objective is an important consideration that would be significantly diluted. Therefore, we strongly recommend that extension of activity levels designed for Phase I into Phase II be an option of last resort.

Table 3a. - Budget Breakdown for Subproject Administration

In-Country Coordination and Logistics		
30 person months (1/2 time for 5 yrs)		
Salary @ 5,042/mo (incl 10% incentives)	151,250	
Benefits @ 20%	30,250	
Differential	22,687	
Family Travel	12,500	
Housing	60,000	
School Allowance	25,000	
Shipping	12,500	
	314,187	314,187
Operations/clerical, local travel, etc. 25,000/yr		125,000
Overhead @ 16%		70,274
Subtotal		509,461
U.S.Based Scientist/Proj. Leaders		
60 person months		
Salary @ 4,583/mo	275,000	
Benefits @ 20%	55,000	
	330,000	330,000
Operating (travel, clerical etc.) @ 50,000/yr		250,000
Overhead @ 40%		232,000
Subtotal		812,000
TOTAL COST		1,321,461

Table 3b. Budget Breakdown for Indian Scientists Travelling to U.S.

1. Career Scientist Fellowships (25)	
Support costs $2,000/mo	
Tour average - 10 mo	
25 persons x 10 mo x $2,000	500,000
Travel 3,000/person	
(includes U.S. travel)	75,000
Tuition & Research support (@ 2,500 x 25)	62,500
Subtotal	637,500
2. Administrative Team (5)	
5 tours - 1 mo each	
Per diem (2,400/mo x 5)	12,000
Travel @ (3,000 x 5)	15,000
Subtotal	27,000
Workshop Trainers to U.S. (6)	
6 tours, 2 mo ea	
Per diem (2,100/mo x 12)	25,200
Travel @ (2,500 x 6)	15,000
Subtotal	40,200
TOTAL COST	704,700

Table 3c. Budget Breakdown for U.S. Scientists to India

1. U.S. Scientist/Long term to India (24 mos)
(during first 2 years of subproject)

Salary @ 5,042/mo (incl 10% incentive)	121,008	
Benefits @ 20%	24,202	
Differential	18,151	
Family Travel	10,000	
Housing	48,000	
School Allowance	20,000	
Shipping	10,000	
Operating/clerical/travel	70,000	
Overhead @ 16%	51,418	
Subtotal	372,779	372,779

2. Initial Team - 5 Scientists to India for 1 mo (5 mos)

Salary (overseas) 5 x 6,600	33,000	
Travel @ 2,500	12,500	
Per diem (2250/mo)	11,250	
Support time 1/2 mo ea	12,500	
(see note b)		
Overhead at 40%	27,700	
Subtotal	96,950	96,950

3. U.S. Scientists on ICAR Priority Projects (40 mos)
Assume 4 mo/scientist x 10 = 40 mo
Average 2.5 trips = 25 trips

Salary	40 x 6600/mo	264,000	
Per diem	40 x 2250/mo	90,000	
Travel	25 x 2500/trip	62,500	
Overhead at 40%		166,600	
Subtotal		583,100	583,100

Table 3c. (contd.)

4. U.S. Scientists on Cooperative Grant Component (21 mos)

Assume 3 mo/scientists x 7 = 21 mo

Average 2 trips = 14 trips

Salary 21 x 6600/mo	138,600	
Per diem 21 x 2250/mo	47,250	
Travel 14 x 2500/trip	35,000	
Overhead at 40%	88,340	
Subtotal	309,190	309,190

5. U.S. Trainers for Workshop/Courses (24 mos)

Assume 6 workshops/courses of 1 mo duration, 2 scientists ea.

12 mo overseas time & 12 mo U.S. time

Salary (overseas) 12 mo x 6,600/mo	79,200	
Salary (U.S.) 12 mo x 5000/mo	60,000	
Per diem 12 mo x 2250	27,000	
Travel 12 x 2500	30,000	
Training materials	12,000	
Overhead at 40%	83,280	
Subtotal	291,480	291,480

TOTAL COST 1,653,499

Note a. Salaries for overseas time assume a base salary of 4,167/mo, 20% benefits, plus a six day work week for a total of $6,600/mo

Note b. Salaries for U.S. time assume 4167/mo plus 20% benefits for a total of 5,000/mo

Table 3d. Budget Breakdown for Graduate Student Exchange

1. Indian Students to U.S. (20) (200 mos)
   Assume av. 10 mo tour, support costs 2,000/mo

Support 200 mo x 2000/mo	400,000	
Fees & books @ 3,000 ea	60,000	
Travel (includes U.S. travel) @ 3000 ea.	60,000	
Subtotal	520,000	520,000

2. U.S. Students to India (10) (90 mos)
   Assume av. 9 mo stay, stipend 1,600/mo

Stipends 90 x 1,600	144,000	
Travel 10 x 2,500	25,000	
Research & logistic support @ 1000	10,000	
Overhead at 40%	71,600	
Subtotal	250,600	250,600
TOTAL COST		770,600

Table 3e. Budget Breakdown for OFRP Staff Training

1.	20 Trainees @ 7,500/1 mo. each (20 mos)	150,000
	TOTAL COST	150,000

Table 3f. Budget for Equipment Support. (See also Table 1)

1.	Micro-computers and accessories 60 @ 4,000	240,000	
2.	Computer system for Project Directorate	60,000	
	Subtotal	300,000	300,000
3.	Basic field & laboratory equipment	500,000	500,000
4.	Equipment for competitive grants and special project support	500,000	500,000
	TOTAL COST		1,300,000

Table 4 - Manmonths of ICAR and U.S. Scientists Programs for the OFWM Subproject during Phase I

U.S. Technical Support (37.6%)	M/months	
1. Subproject Administration (Table 3a) by U.S. Contractor/and in-country tng. coord (1 person x 6 mo x 5 yrs) (1 person x 12 mo x 5 yrs)	90	
2. U.S. Workshop Trainers (Table 3c) (2 persons x 2 mo x 6 courses)	24	
3. Other U.S. Scientists visits to India (Table 3c) (incl. 1 person x 12 mos x 2 yrs)	90	
4. U.S. Graduate Research Associates to India (Table 3d)	90	
U.S. Subtotal		294
ICAR Scientists (62.4%)		
1. ICAR Advance Team to U.S. (Table 3b) (5 persons x 1 mo)	5	
2. Career Scientists Fellowships (Table 3b) (25 persons x 10 mo)	250	
3. Workshop Trainers to U.S. (Table 3b) (6 tours x 2 mo)	12	
4. Indian Graduate Students to U.S. (Table 3d) (20 persons x 10 mo)	200	
5. OFWM Team Training (Table 3e)	20	
ICAR Subtotal		487
TOTAL U.S./ICAR SCIENTISTS EXCHANGE		781

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VII. APPENDIX

Item 1 Itinerary of Design Team Visits to ICAR Research Stations and Field Sites

Item 2 "Proposal for Organizational Research Project on Rice and Sugarcane in Periyar - Vaigai Area"

Item 3 Proposal for Study of "Conjunctive Use of Ground Water and Surface Water for Optimal Irrigation Management and Cropping Pattern in River Basin Projects Under Different Rainfall Situation"

Item 4 World Bank "Guidelines for Preparation and Implementation of NARP II Supplementary Components -- Water Management and Farm Implements"

ITEM 1

ITINERARY FOR DESIGN TEAM "ON-FARM WATER MANAGEMENT"

DATE/DAY		PROGRAMME	CONTACT PERSON
18 Jan (SUN)		Nobe and Reuss arrive Stay at Ashok Hotel	
19 Jan (MON)	11:00	Room 352 Ashok Hotel	
	11:30	Briefing ICAR Dr. Guy Baird, Winrock to accompany	DDG (SAE)
	14:45	Room 352 Ashok Hotel	
	15:00	Ministry of Water Resources Command Area Dept. Mr. D.R. Aurora, IRRAG/ USAID to accompany	1. Shri Telang, Addtl. Secretary (Shram Shakti Bhavan) 2. Shri S.N. Lele, Chief Engineer (Krishi Bhavan) 3. Shri Datta, Chairman, Central Ground Water Board (Krishi Bhavan)
	16:00	Central Water Commission, Sewa Bhavan Mr. Aurora to accompany	Shri M.S. Chitale Chairman
20 Jan (TUE)	09:00	Meeting with USAID (AR/ID, IRRAG, WI) - Room 1501 Ashok Hotel	Dr. Mark Smith
	14:00	Leave for Hissar by USAID car Mr. Aurora to accompany	
	16:30	Arrive Hissar ICAR to arrange Guest House	
21 Jan (WED)	AM	Dept. of Soils, Haryana Agric. University	Dr. Mahendra Singh, Director of Research
	PM	Travel to Karnal by car Mr. Aurora to accompany ICAR to arrange Guest House	
22 Jan (THU)	AM	Central Soil & Salinity Research Institute	Dr. R.C. Mondal, Director

23 Jan (FRI)	AM	Travel to Dehra Dun by car Stay at Meedo's Grand Hotel Dr. N.K. Tyagi, Head, Division of Engineering, CSSRI, Dr. R.K. Rajput, Project Coordinator, CSSRI and Mr. N. Bannerjee, IRRAG/USAID to accompany	
	PM	Central Soil & Water Conservation Research & Training Institute	Dr. V.V. Dhruva Narayana Director
24 Jan (SAT)		Return to Delhi by car Stay at Samrat Hotel	
25 Jan (SUN)		FREE	
26 Jan (MON)		Republic Day	
	06:20 10:05	Depart Delhi Arrive Madras	IC439
	14:00 14:50	Depart Madras Arrive Madurai Stay at Madurai Ashok Hotel Dr. G.N. Kulkarni will join	IC501
27 Jan (TUE)		ICAR Water Management Project	Dr. Purshottaman Chief Scientist
	15:20 16:10	Depart Madurai Arrive Madras Stay at Chola Hotel Mr. Dennis Wendell, IRRAG/USAID to join team	IC502
28 Jan (WED)	08:20 10:10	Depart Madras Arrive Coimbatore Stay at Hotel Annapurna	IC533
	PM	Water Technology Centre, Tamil Nadu Agric. University	Dr. Kandaswamy
29 Jan (THU)	AM	Water Technology Centre	Dr. Kandaswamy
	Noon	Travel to Bhavanisagar	

30 Jan (FRI)	10:40 11:20	Depart Coimbatore Arrive Bangalore	IC534
	16:30 18:00	Depart Bangalore Dr. G.N. Kulkarni, Zonal Coordinator, Dharwad to accompany Arrive Bombay Stay at Centaur Hotel Mr. B.N. Maheshwari, IRRAG/USAID to join team	IC108
31 Jan (SAT)	06:50 07:25	Depart Bombay Arrive Pune Stay at University Guest House	IC101
		Dept. of Irrigation and Water Management, Mahatma Phule Agric. University	Dr. S.S. Magar
1 Feb (SUN)		FREE	
2 Feb (MON)	17:20 17:55	Depart Pune Arrive Bombay Stay at Centaur Hotel Dr. Glenn Anders, IRRAG/USAID to join at dinner	IC158
3 Feb (TUE)	06:15 06:55	Depart Bombay Arrive Aurangabad Stay at Rama Hotel Dr. Dennis Wendell to accompany	IC492
3-4 Feb (TUE-WED)		Water & Land Management Institute	Dr. Jangle, Director
5 Feb (THU)	07:25 11:35	Depart Aurangabad Arrive Delhi	IC492
6 Feb (FRI)		Visit to Water Technology Centre - IARI	Dr. A.M. Michael, Director, IARI
7 Feb (SAT)	06:40 09:25	Depart Delhi Mr. D.R. Aurora to accompany through 13 Feb Arrive Udaipur Stay at Lake Palace Hotel	IC491
8 Feb (SUN)		FREE	

9 Feb (MON)		Dr. J. Mohan Reddy arrives	
	06:40	Depart Delhi	IC491
	09:25	Arrive Udaipur	
9-12 Feb (MON-THU)		Participate in workshop of All-India Coordinated Project on Water Management Sukhadia University, Udaipur	Dr. R.K. Rajput and Dr. G.L. Jain, Prof. and Head of Dept. of Agronomy
13 Feb (FRI)	08:55	Depart Udaipur	IC492
	11:35	Arrive Delhi	
	15:15	Meeting in 352	
	16:00	Meet Dr. Bhatia-ICAR Room 302	
14 Feb (SAT)		Work on report	
15 Feb (SUN)		FREE	
16-21 Feb (MON-SAT)		Report writing (Nobe and Reuss) *	
19 Feb (THU)	10:10	Meeting 1501 (Nobe & Reuss)	

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16 Feb (MON)	09:15	Dr. P.C. Bhatia will arrive Patna and meet others on their arrival on 17th	
17 Feb (TUE)	5:50	Mohan Reddy - Depart Delhi and Dr. Ronald H. Pollock (USAID) will accompany	IC489
	07:15	Arrive Patna ICAR to arrange University Guest House at Pusa	
18-19 Feb (TUE-WED)		Department of Agric. Engg., RAU, Pusa	Dr. R.K. Rai, Dean, Agric. Engineering
		Water and Land Management Institute, Pusa	Shri Satya Prakash, Director
20 Feb (THU)	08:40	Depart Patna	IC410
	10:10	Arrive Delhi	

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22 Feb (SUN)	FREE
23-27 Feb (MON-FRI)	* Report writing - Meeting early in week with D.G., SAE Division and Drs. Michael and Rajput) to present highlights of report (conclusions and recommendations)

* Rooms for work - 1528 and 1543

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1. Project Title:

Conjunctive use of Ground Water and Surface water for optimal irrigation management and Cropping pattern in River Basin Projects under different rainfall situation.

2. Scope of the Project:

In the past three decades, there has been a large public investment in irrigation projects. By and large, it is observed that the irrigation potential created through these projects remain under utilized and the irrigation management is generally not conducive to scientific cropping system. There is urgent need to realise fuller benefits of irrigation system through evolution of a suitable diversified cropping system that includes pulses, oil seeds, sugarcane and others which are far short of domestic demand.

The present study aims at developing an optimal management of irrigation and a cropping pattern in the command area from a holistic point of view. Optimal management of irrigation and concomittant cropping pattern in river basin projects in India have been attempted by Maji, Hiremath, Singh and others. However, these earlier studies have not considered conjunctive use of ground water, rainfall distribution and surface water in their allocation models. In the present context of limitation in expansion of major irrigation system in Tamil Nadu, Conjunctive use of water assumes greater significance.

3. Objectives:

(1) to develop optimal decision rules for reservoir management and simultaneously evolving an optimal cropping pattern in the command area by considering the

physical, economic, social and structural constraints as well as their interdependence under different rainfall situations.

(2) to examine the effects of changes in prices of critical inputs (fertilizer, irrigation labour) and of major crops as well as in available resources on cropping pattern, water allocation, production, income and employment.

(3) to examine the policy implications of the effects observed in (2) and to suggest policy prescriptions at the national/regional level.

4. Utility of the Project:

The findings of the study will help in evolving a suitable cropping system in the command area that will maximise annual net return from the region. Further, the study will help in developing suitable policy package for effective reservoir management and crop pattern..

5. Duration: 36 months

(i) Preliminary arrangements (Review, Reconnaissance survey, sampling and formulation of Questionnaire)	-	6 months
(ii) Field survey (Collection of primary and secondary data)	-	18 months
(iii) Analysis of data	-	6 months
(iv) Write-up of the report	-	6 months

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6. Technical Programme:

Lower Bhavani irrigation system is selected for the present study. The region benefited would be delineated into homogeneous sub-zones in terms of irrigation, rainfall and crop pattern.

Linear Programming model will be used as the basic analytical tool with the following variations:-

(a) Chance-Constrained Programming (CCP to handle stochastic rainfall situation and to obtain a safety interval within which the decisions should fall most of the time rather than all the time;

(b) Parametric Programming to study the effect or systematic changes in input and output prices as well as the level of resources. This analysis will be confined to important and/or unstable parameters only.

The salient features (decision variables, constraints and parameters) of the model are described below:-

Objective function: To maximise annual net return from the command area.

Decision variables: The major decision variables of the model are:

Regionwise area under each crop/variety, quantity of canal water to be released from the reservoir at each time period for each region, quantity of ground water to be used for irrigation in each region and time period, regionwise and labour use, quantity of canal water to be stored in the reservoir in each period, production of important selected crops in the command area, spillage of reservoir water (quantity and timewise), regionwise income as well as income from the command area.

Constraints:-

Regional land maximum area to individual crop, seasonal land use, labour minimum production/average of selected crops, credit, reservoir capacity, canal capacity, storage inflow(stream flow), irrigation requirement fertilizer, hydroelectricity generation, maximum discharge from individual tubewell, maximum available ground water for the command area. The above constraints will contain time dimensions in addition to quantity dimension and will be related with one another on the basis of hydrological, structural and physical interdependence.)

7. Staff requirements and fund:

(1) Assistant Professor	:	~~Six~~ Two
(2) Field Investigators	:	Six
(3) Compilator cum Tabulator	:	One
(4) Total fund	:	Rs. 1.80 lakhs for three years with 100% ICAR Fund (Revised Estimates for Rs. 2.63 lakhs sent to ICAR for approval)

8. Scientist incharge:

Dr.V.RAJAGOPALAN Ph.D
Vice-Chancellor,
Tamil Nadu Agricultural University,
Coimbatore - 641 003

Assisted by:

Dr.S.Krishnamoorthy, Ph.D
Associate Professor,
Department of Agricultural Economics,
Tamil Nadu Agricultural University,
Coimbatore - 641 003

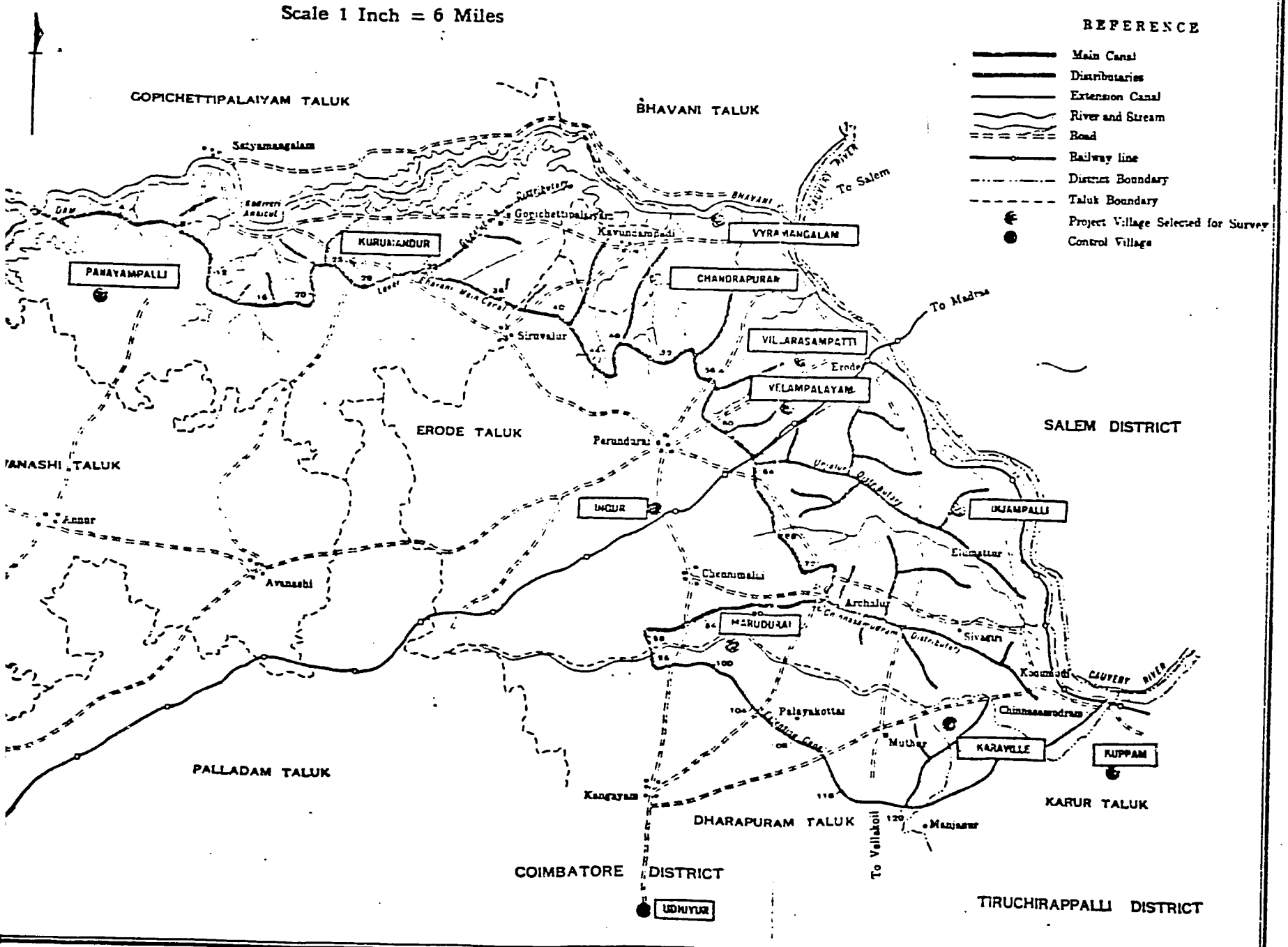
9. Remarks:

Sanction Order: S1.F.322/85 of the Registrar, TNAU, Coimbatore dated:14.12.1985

The scheme started functioning with the joining of one Assistant Professor Selvi.T.Alagumani on 3.6.86.

LOWER BHAVANI PROJECT AREA

Scale 1 Inch = 6 Miles



PROPOSAL FOR OPERATIONAL RESEARCH PROJECT ON RICE AND SUGARCANE IN PERIYARU-VAIGAI COMMAND AREA

Submitted by : Tamil Nadu Agricultural University
ICAR-Coordinated Project for Research on Water management
Agricultural College and Research Institute,
Madurai-625 104
Tamil Nadu (INDIA)

CHIEF SCIETIST : DR. S. PURUSHOTHAMAN,

1. INTRODUCTION

For transferring the tested and proven method of water management technology to the farmers, the 'Operational Research Project' on rice at farmers' holdings has been taken up by Water Management Scheme of this Institute.

The objectives of the project are:

1. Demonstrating the water management to the farmers.
2. Monitoring the water requirement of the crop and water losses in the field.
3. Assessing the effect of equitable water distribution among the farmers' fields.
4. Calculating water use efficiency.
5. Assessing the response of the farmers to adoption of water management technology.

During this year "Operational Research Project" is being conducted in the command of the sluices 14R and 15L of 6th Branch Canal (BC) of Periyaru Main canal (PMC), having the command under one sluice as control plot and the command under the other sluice as treatment plot. In the control plot irrigation by continuous flooding as adopted by the farmers is allowed while the technology of applying 5 cm depth of water after the disappearance of ponded water is followed in the treatment plot. The results show that about 20 per cent of irrigation water

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could be saved by adopting water management technology without any detriment to the yield. The ICAR has expressed its appreciation of the Operational Research Project conducted by this centre.

At present one Professor of Agronomy and one Assistant Professor of Agricultural Engineering from Water Management Scheme are incharge of the project. They are being assisted by one Agricultural Assistant from the water management scheme and two casual mazdoors. These scientists are not able to devote their full attention to this project as they have additional projects in the campus. Further, lack of transport facility and T.A. hampers the frequent visit by the staff.

With the available staff and resources the collection of particulars on quantity of water supplied, quantity of drainage water from the command, yield attributes and water use efficiency only could be done. Collection of data on cultural operations, weed and pest incidence, constraints on labour, implements, quality seeds and economics of cultivation could not be done.

When the World Bank team along with officials from Government of India and Tamil Nadu Agricultural University visited the Operational Research Project area presently conducted by the ICAR (Indian Council of Agricultural Research) Water Management scheme in small way on 13.11.84, it was of the opinion that better results could be obtained by a multifaceted study in an area of 1000 acres each with rice and sugarcane, both are predominant crops in the command area.

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2. GENERAL AGRICULTURAL CHARACTERISTICS OF THE ZONE

The Periyaru-Vaigai command Area situated in the Southern zone. The climate is tropical type with dry summer extending from March through June. The mean annual rainfall in this zone is 776 mm, whereas in the command area it will be slightly higher (800 mm), the bulk of which is received during North East Monsoon (October-December).

The Periyaru-Vaigai Command Area, for which this study was proposed comprises 9 soil series viz., Vyologan, Amaiyur, Madukkur, Pilavidathi, Erugur, Peelamedu, Kalathur, Padugai and Alathur, each with different nutrient status, and soil moisture characteristics. The important crops are Rice-Rice or sugarcane or wetland banana and in some pockets jowar and groundnut.

3. AGRONOMIC PROBLEMS OF THE COMMAND AREA

1. Inequitable distribution of water from head end to tail end farmers.
2. Inundation in the lower reaches and improper drainage facilities.
3. Poor maintenance of channel and control structures.
4. Prolonged cultivation operations beyond the stipulated period.
5. Age old cropping system irrespective of water resources availability.
6. Excess utilisation of water.
7. If the water is used according to the need, it is possible to extend the area of the command in the vast dry tracts of Ramanathapuram and Pasumpon districts of Tamil Nadu.
8. After closure of the dam most of the command area fields are kept fallow.

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4. EXISTING RESEARCH FACILITIES

a) Existing research projects/programme, staff, contingencies etc.

At present one ICAR Coordinated Project for Research on Water Management functions at the Agricultural College and Research Institute, Madurai campus on 75% : 25% cost shared by the Indian Council of Agricultural Research and Tamil Nadu Agricultural University respectively. Apart from other project works the following staff of the scheme are also looking after the ongoing Operational Research Project on rice.

Professor of Agronomy (Chief Scientist) assisted by Assistant Professor in Agrl.Engineering, One Agricultural Assistant and two casual mazdoors for orderly water guiding.

Budget provision:

No separate budget provision for the Operational Research Project except cost of conveyance borne by the University. Other charges like wages for the mazdoors and Travelling Allowances are met from the scheme funds, which is very very limited.

b) Existing infrastructural facilities like laboratory, housing, farm buildings, farm area and equipment:

Nil

c) Significant achievements

Achievements of ICAR-Water Management Scheme on rice and sugarcane

RICE:

The farmers usually irrigate rice by continuous flooding and waste enormous quantity of water. Water management research has shown that irrigating to a depth

of 5 cm on disappearance of ponded water gives the same yield as that of continuous submergence with better water use efficiency accounting for a saving of about 35 per cent of irrigation water.

Sugarcane

Irrigating sugarcane through gradually widened furrows for main crop and through alternate furrows in the ratoon crop was found to be economical in view of the limited zone of wetting.

Based on the evaporative demand the following irrigation intervals were recommended taking into account optimum IW/CPE ratio as 0.75 with 6 cm depth of water.

March/April/May/June/July/August	- 8-10 days
October/November/December	- 16-18 days
September/January/February	- 12-14 days.

5. FUNCTIONS OF THE PROPOSED RESEARCH PROGRAMME

So far the efforts have mainly been concentrated on 'Water conservation without any adverse effect on yield' in an area of about 40 acres. It is now being realised that a comprehensive study in an area of about 1000 acres including the following aspects will be very useful.

1. Adoption of water management technology
2. Its effect on weed growth and pest incidence.
3. Evaluation of resource constraints such as labour, animals, implements, machineries and quality of seeds.
4. Assessing the effect of timely cultural operation taken by the institution offering to plough the land.
5. Working out the economics of implementing such a scheme.
6. Identifying socio-economic constraints and suggesting suitable organisational and legislative measures to enable the farmers to adopt the technology by themselves.

It is also proposed that another crop, namely sugarcane, in a limited area of about 100 acres to start with, may also be brought under the purview of the project with the adoption of the tested water management technology for sugarcane, i.e.,

'Irrigation through gradually widened furrows for main crop and through alternate furrows for ratoon crop

6. Detailed programme of the work proposed

Plan of work

Ist Year

1. Preparing a detailed Plan for operation, observations and surveys.

2. Starting the execution of the plan.

IInd year:

1. Evaluation of 1st year work to find out the short comings and failures.

2. Modification of the plan.

3. Execution of the modified plan.

IIIrd year

1. Evaluation of IInd years work

2. Modification, if any, of the plan and its execution.

IV year

By now a good workable plan would have been obtained, constraints specified and ways to overcome the constraints found.

At this stage, the farmers are to be invited and involved, in the adoption of the technology.

Vth year:

With minimum guidance from the scientists, the farmers should be able to follow the recommended technology.

7. STRENGTHENING SUGGESTED (Mean years : 5)

i) Staff:

For satisfactorily conducting the proposed project on a thousand acre plot, the following full time staff and facilities will be required to look after Operational Research Project as a separate entity under the control of the existing Professor of Agronomy (Chief Scientist) (ICAR-Water management Scheme).

1. One Agricultural Engineer in the cadre of Associate Prof
2. One Agronomist -do-
3. One Agrl.Economist -do-
4. One Assistant Professor of Agrl.Engineering
5. One Assistant Professor of Agrl.Extension/Sociology
6. Two Agricultural Assistants
7. Two Technical Assistants with Diploma in Engineering
8. One Junior Assistant and One Typist for the preparation of report and other script work.
9. One Driver for jeep/van
10. Two Basic servants
11. Casual mazdoors One per 10 ha area
12. One Jeep/van
13. Two No.of two wheelers

Total cost of personnel : Rs.10.00 lakhs

II. Civil works:

A. Temporary field lab.cum stores for water measuring appliances cum working place for field staff at 2 places (Rice area and sugarcane area)-This can be either made available through temporary sheds or if available through rental basis. : Rs. 0.30 lakhs

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III. Equipments:

A. Water measuring equipments	: Rs. 0.50 lakhs
B. Basic Meteorological instruments	: Rs. 1.00 lakhs
C. One Minibus or van	: Rs. 1.40 "
D. Two wheeler 2 Nos.	: Rs. 0.40 "
E. Furniture to be provided at the Head quarters and at field labs.	: Rs. 0.40 "
F. Type writer	: Rs. 0.10 "
G. Moisture estimation instruments	: Rs. 0.50 "
Total	: Rs. 4.60 lakhs

IV. Operational cost

A. Travelling Allowance	: Rs. 0.80 lakhs
B. Charges for subsidising the ploughing of the farmers [illegible] to have [illegible]	: Rs. 1.00 "
C. Wages for casual mazdoor for guiding water @ 1 per ha	: Rs. 4.32 "
D. Maintenance of vehicle, fuel, and supply of materials like stationery	: Rs. 2.44 "
Total	: Rs. 8.56 lakhs

8. ORGANISATIONAL SET UP

Vice-Chancellor

Director of Research (Agri)/Dean/Director(NTC)

(Chief Scientist)Professor of Agronomy(Existing-ICAR-NMS)

(Scientists)Associate Professor in Agronomy,Agrl.Engineering
Agrl.Economics

Assistant Professor in Agrl.Engineering,Agrl.Extension

Supporting staff of the scheme

9. LINKAGE WITH EXTENSION:

Linkage of officials from State Department of Agriculture, ~~AAAAA~~ Command Area Development Agency, Public works (irrigation) are very much essential in the selection and motivation of participating farmers, water regulation and water distribution.

10. COST ESTIMATE: (for 5 years)

		Lakhs
1. Cost of personnel	Rs.	10.00
2. Civil works/rental		0.30
3. Equipments		4.60
4. Operational cost		8.56
	Total	23.46

11. JUSTIFICATION AND RECOMMENDATIONS

Research findings give no benefit to the nation unless they are transferred to the farmers and practised in the fields.

Due to various reasons the farmers are not able to practise the advice given to them. In this project the scientists involve themselves in utilising the research findings. They will identify the constraints, find ways to eliminate the constraints and persuade the farmers to adopt the recommended technology.

There is another beneficial aspect in this project. Involvement of scientists in the transfer of technology helps them to get a better grip of the realities and problems in the field, and it will lead to their modifying the research programmes to better suit the realities (feed back).

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12. ABSTRACT OF PROJECT COST ESTIMATED BREAK-UP
(For the Seventh plan-period)

(In lakhs)

	1987-88	1988-89	89-90	90-91	91-92	Total
1. Cost of personnel	1.50	1.60	2.00	2.30	2.40	10.00
2. Civil works	--	0.30	--	--	--	0.30
3. Equipments	--	3.00	1.60	--	--	4.60
4. Operational cost	0.56	2.00	2.00	2.00	2.00	8.56
Total	2.06	7.10	3.60	4.30	4.40	23.46

(Scale of pay of staff enclosed)

Chief Scientist
ICAR-Coordinated project for
Research for water management
Thanjavur Centre

PJH/23.1.

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Pay structure

	Scale of pay
a) Technical staff	
1. Professor (Chief Scientist	1700-60-1800-100-2000-125/2500
2. Associate Professor(Scientist)	1200-50-1300-60-1900
3. Assistant Professor	700-40-1100-50-1600
b. Supporting staff	
1. Office Superintendent	905-45-1445-50-1545
2. Assistant (Senior clerk)	795-20-745-25-845-35-1230
3. Accountant Assistant	-do-
4. Stenotypist (Junior Stenno)	610-20-730-25-955-30-1075
5. Junior Assistant	-do-
6. Jeep Driver	555-15-615-20-795-25-970
7. Lab.Assistant	-do-
8. Peon servant	430-10-570-15-720

Best Available Document

WORLD BANK OFWM PROPOSAL

GUIDELINES FOR PREPARATION AND IMPLEMENTATION OF NARP II SUPPLEMENTARY COMPONENTS - WATER MANAGEMENT AND FARM IMPLEMENTS

The broad outlines of Phase II components of NARP have already been circulated by ICAR vide D.O.No.1-17/84.Edn.IV dated January 7, 1986. During subsequent visits to the regional research stations, it has been pointed out that the understanding of the basic concepts and the establishment of coordination mechanisms are essential for the successful implementation, within NARP II, of research on (i) crop water management, and (ii) farm implements. The Phase II components are to fit in the existing system of zonal research coordination and the proposed mechanism for integration of research and development planning with the current system of research-extension linkages. Some of the features, which are essential for the preparation and implementation of both components, are briefly described in this paper, for guidance. It is strongly recommended that Phase II components be based on the area analysis of the Status Reports and that research proposals be prepared in consultation with the Departments of Agriculture, Horticulture, Animal Husbandry and Dairy, Irrigation and other agencies related to Agriculture.

CROP - WATER MANAGEMENT

Crop water management research is included in NARP II with particular emphasis on on-farm water management within commands of large Irrigation schemes, but would also include on-farm irrigation in tank systems and in tubewell commands. The first step of this operational research component is to identify suitable locations, in the form of typical outlet commands in which the major farming situations of the scheme are represented with the objective to demonstrate economically feasible and replicable technology which can be applied on a large scale on other such commands. Besides agricultural scientists from the zone concerned this will require involvement and participation of the Irrigation Department, DOA, CADA, WALMI and the farmers located in the project. The important steps involved in the planning and implementation of such crop water management research are given below:

Step 1 - Identification of Farming Situations in the Command

The farming situations in most commands will depend on soil types, variablity in rainfall and the water delivery systems within the command. More in particular, the following essential parameters should be known:

Note: Provided by T.S. Bredero, World Bank Mission, New Delhi during review of design team OFWM Subproject report in USAID Office February 19, 1987.

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Soil: Texture, depth infiltration rates, water holding capacity, water table, suitability for irrigation; chemical characteristics of the soil profile, in particular related to alkalinity and salinity hazards deeper in the profile;

Rainfall: variability with respect to total rainfall and its distribution in time and space;

Other Climatic Factors: wherever the variability is there, these factors should be considered.

Water Delivery System:

(a) Opening and closing time of the main canals and distributaries for intermittent or continuous supply situations;

(b) Minor/outlet distribution system with the volume delivered and its supply interval, the capacity of the conveyance system, and the actually irrigated area of the command;

(c) Quantity, frequency and quality of water from other sources, available for conjunctive use with water supplied by the scheme.

Cropping Pattern. Variation in cropping pattern according to location within the command area, using the denotation of the conveyance system (distributary or minor number).

Thus a complete knowledge of the irrigation project and its delivery system and farmers response to the actual system is essential for identifying the farming situations and the extent of each situation in the command; factors which normally are not taken into account during on-station research.

Step 2 - Identification of Representative Minor/Outlet as Sites for Operational Research

Operational research has to be based on the identified farming situations. Since it is not possible to cover all the farming situations of the command, only those outlets which represent the major (based on area) farming situations in the command are to be selected. Command outlets to be included in the tests may be located on the same minor or sub-distributary, if they represent a different farming situation. This should be done in collaboration with the Irrigation Department, DOA Extension staff and farmers' representatives. Usually, an outlet will have a discharge of about one cusec with a command area of about 30-50 ha. Not the command area as such, but its representativeness of the major farming situation should be the criteria for selection.

Step 3 - Program Planning

The following six major research aspects may be researched, separately or in combination with one another, dependent on the conditions of the current and new operational plan:

(a) field preparation and field shaping techniques to receive and distribute irrigation water efficiently and permit drainage of excessive rainfall or irrigation water; development and testing of farm implements for the field preparation and shaping;

(b) potential cropping sequences, including new crops which could be of interest to the farmers concerned, and as a logical sequence to this, the water efficieny of cropping systems[1/], which would maximise the returns per unit of water, taking into account operational limitations of the distribution system and the local farming situation;

(c) rates of water application and/or irrigation intervals as part of the experimentation with the system operation, while existing cropping patterns and sequences might be maintained or adjusted;

(d) water balances and water consumption within selected outlet commands both under the current and improved/adjusted operational plan. Here, frequent recording of ground water tables in the selected command outlets will be necessary, to determine seepage losses and possible contribution from ground water tables through capillary rise; to detect critical levels of ground water, and to explore the potential conjunctive use of ground water with water supplied by the scheme. Such conjunctive use of groundwater through capillary rise may influence the length of irrigation intervals. Runoff losses of outlets or group of outlets (minors) should also be measured in the collector or natural drains of the command outlet in question;

1/ Cropping systems which optimise the physical production or net monetary returns of this production for the quantity of water used.

(e) <u>improved on-farm agronomic practices</u>, such as pre-tillage and other water applications[1/], field preparation and line sowing techniques, using appropriate farm implements, as well as new crops and/or varieties, fertilizer rates, plant protection etc.

(f) <u>production parameters</u> such as timing of the field operations, cropping patterns and input use within the variability of the farming situations identified in a certain command area. This analysis would be comparable in its objectives and methodology to a yield gap and production constraint analysis.

Under (a) and (b) above, not only various crops but varieties of different duration, timing of field operations, pest and disease management, and soil fertility management can be tested. All operational research indicated above requires involvement of the following agencies:

(i) University scientists

(ii) Irrigation Engineers

(iii) CADA officials

(iv) DOA Extension staff

(v) Farmers/land owners under the project site.

<u>Step 4</u> - <u>Project Implementation</u>

The project is to be implemented at selected field sites within the scheme but has to be planned and monitored by the nearest research station charged with crop water management research. It calls for a steering committee at the zonal or command level and for an implementing agency at site:

(i) <u>The Steering Committee</u>.

This should be constituted at the level of irrigation project/zonal level and may consist of the following

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1/ Excessively large amounts of water are to often applied by farmers, in particular prior to the first land tillage operation, presumably to store maximum water in the soil profile early in the season and to guard themselves against water shortages caused by uncertain water supplies later in the growing season.

members:

(a) University: 1. Most senior Irrigation scientist or Director of Research or Dean of the Faculty - Chairman.

2. One senior scientist each in Soil Physics, Agronomy and Agricultural Engineering, which could include the Chairman.

(b) Irrigation Engineers: Administrator/SE - member Nominee of Administrator.

(c) DOA: Addl.Director Agriculture/his nominee Jt.Director - member

(d) Farmers representative: One or two representatives of the farmers committees in the command.

(e) WALMI: One representative, wherever applicable[1/].

(f) Associate Director of Research in the zone.

This 7-8 member team will review and monitor all the on-farm research programs in the zone/under the command and will have regular contact with the implementation team through the Associate Director Research/Executive Engineers/Deputy Director of Agriculture operating in the concerned commands.

(ii) Project implementation at site

This should consist of the staff located at the project site for implementation of day to day work and should consist of:

(a) University: Two asst.Professors - one in Agronomy/ Soil Physics/Agricultural Engineering and the other in Agricultural Economis and a number of overseers/field assistants (2, at each site) for each command depending on the number of outlets selected for the operational research program.

(b) Subdivisional Engineer (DEE) or Executive Engineer (EE) or Asst/Jt.Engineer or whoever is responsible for the actual water delivery to the command outlet in question.

1/ The task of WALMI is exclusively training of Irrigation and Agriculture Department staff. Their role in the Steering Committee is, therefore, strictly advisory.

(c) Asst.Director/Field Supervisor and VLW/VEW of the area from DOA.

The staff of the Steering Committee as well as the implementing agency would be drawn from the existing staff of the agencies concerned. However, the University staff to be located on site is to be funded through NARP and will include the supporting facilities, transport, operation costs and field equipment required for the studies.

Step 5 - Program Monitoring

Besides the regular supervision as part of the NARP implementation by ICAR and the World Bank, the program has to be regularly monitored at state level by the Director of Research and by the CADA Administrator (if appropriate) at scheme level. Constitution of a state level coordinating committee will be essential for an effective implementation of the ORP under the chairmanship of APC with the Secretary of Agriculture and Irrigation and Vice Chancellor as members to review and sanction the programs and resolve policy issues which may occur.

Since a large number of farming situations cannot be covered all at once, the location of the on-farm research programs may be expanded gradually to other outlets in order to reach over time, a coverage of the most important farming situations.

Wherever needed, specialised training programs on specific aspects could be arranged by ICAR and/or WALMI for the members of the Steering Committee at State and University level and for the implementing staff.

FARM IMPLEMENTS

This component has been included among the supplementary Phase II components in order to identify and test improved farm implements for their potential use under different agro-climatic conditions, promote successful ones and modify others according to the specific requirements of the zone and farming situation. There is no need for designing new implements since a large number of implements have been developed for different situations inside and outside India. Additional prototypes should be manufactured in the faculty workshops or by private manufacturers for distribution to the ZRSs. While identifying and testing of an implement, the economic status of the farmer's and specific farming situation should be taken into consideration. The object is not to promote a particular implement, but to find a suitable implement to help the farmers in solving some of their most difficult problems. Emphasis should be given to simple, low cost implements, even if they are small tools, which can be utilized by a large number of farmers within their means and to help them in their day-to-day work, rather than trying some sophisticated tractor drawn implements, useful only for a few rich farmers. The following steps are recommended:

Step 1 - Coordination at National Level

A systematic coordination mechanism at national level between CIAE Bhopal, SAU Engineering Faculties and the zonal research stations (ZRS) has to be established. Agriculture Engineers would have to be posted at each ZRS and would conduct together with DOA extension staff, a farm survey in the zone to assess the implement situation and identify the need for improved implements in the zone. For this purpose CIAE would have to be requested to widen its research activities so as to cover the full range of animal drawn implements to be used in irrigated and rainfed agriculture as well as appropriate post-harvest equipment. Its program would have to be based on the needs identified in the zones during Status Report preparation. Based on the results of the amalgamated zonal and state surveys the CIAE could prepare a national program and organise the distribution of prototypes of implements of potential use to the SAUs. CIAE could build up a collection of prototypes successfully developed and or used inside India as well as in other countries.

The existing mechanism of coordinated programs on farm implements for which most SAUs have assigned a research centre would have to be reactivated. Coordination between this state centre and the ZRSs would need to be established at the level of the SAU's.

Step 2 - Identification of Suitable Implements

This would be done by Agricultural Engineers posted at the ZRS in consultation with the SAU staff in the research centre of the coordinated farm implement program or at the faculty of Agricultural Engineering. The SAU headquarters staff will identify the implements available at CIAE and SAU's and provide ZRS with the appropriate implements selected for testing. The final choice should be left to the zonal Agricultural Engineer, who is supposed to have first hand knowledge and appreciate farmers' requirements for implements.

Step 3 - Testing and Recommendations

The selected implements would be tested by the zonal Engineer at the research station and based on his experience and observations might proceed to the following action:

(a) If found suitable the implement should be tested on farmers' fields in collaboration with DOA staff, and if accepted, promoted through DOA. An adequate number should be made available for testing through collaboration with local agro-industries. If required, available subsidies could be utilized for promoting such implements in the initial stages.

(b) If the implement proves to be suitable generally, but requires some modifications, it may be referred back to the SAU headquarters with a request for desired modifications. The implement with modifications can then again be tested under farming condition.

Step 4 - Starting Up of Manufacturing

If proven successful and acceptable to the farmers, who participated in the testing, the next step would be to manufacture a larger (500-1000) number for introduction on a wider basis. Available subsidies could be utilized to promote the implement on such a larger scale. The subsidies could be paid to potential manufacturers. In addition, credit facilities could be extended to local (usually small) agro-industries through NABARD coverage in order to cover the starting up costs, (investment in equipment, tools etc.) and cover losses in the initial years of production until the demand for the product has been well established.

Proposed strengthening of Zonal Programs

It is evident that an attempt should be made to utilize already available facilities and resources. However, some strengthening might be necessary for the zones where such facilities do not exist. The broad criteria for additional facilities under this component may be examined on the following basis:

(a) There must be one Agricultural Engineer (Associate Professor level) at all the regional research stations who is familiar with farm implements. Before considering the additional post, it should be examined whether the work could be taken up by existing staff. The rest of the manpower facilities can be utilized from existing staff, e.g., a supervisor level man can be considered if it is not at all possible to take help from existing staff.

(b) Sufficient provision has to be made for the purchase of implements to be tested. An additional amount of Rs.50,000 over a period of four years would be considered over and above the normal contingency grant of Rs.12,000/year per scientist to meet his requirements.

(c) Most of the zonal stations have small workshops. However some additions can be considered for minor repairs and maintenance as there is no provision of manufacturing, designing and modifications at these stations.

(d) Closer contacts should be developed with DOA staff, farmers and local artisans to understand and appreciate the specific needs of the farmers.