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NORTHEAST

SMALL SCALE IRRIGATION

PROJECT PAPER ANNEXES

USAID/Thailand
July, 1980

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AMERICAN EMBASSY BANGKOK

PROJ: 493-3/2

ACTION USAID-5

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Annex A

PID Approval Cable

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TAGS:

SUBJECT: NORTHEAST SMALL SCALE IRRIGATION (493-0312)

REFS: (A) BANGKOK 32418; (B) STATE 211710

1. THE ASIA PROJECT ADVISORY COMMITTEE (APAC) MET DECEMBER 12, 1978, AND APPROVED THE SUBJECT PROJECT AS AN FY 80 SHELF ITEM WITH THE UNDERSTANDING THAT, IF SUFFICIENT FUNDING IS NOT AVAILABLE IN FY 80, THE PROJECT WILL BE INCLUDED IN THE FY 81 PROGRAM. IN THE APAC'S VIEW, USAID/T SHOULD PROCEED WITH DEVELOPMENT OF THE PP.

2. AS A RESULT OF AN EARLIER REVIEW OF THE SUBJECT PID BY THE PROJECT COMMITTEE (PC) ON DECEMBER 5, 1978, A NUMBER OF CONCERNS WERE DEVELOPED FOR AN ISSUES PAPER FOR THE APAC. THESE INCLUDED THE FOLLOWING ISSUES WHICH SHOULD BE TAKEN INTO CONSIDERATION IN PROCEEDING WITH PROJECT DESIGN:

....A- WITH REGARD TO PARTICULAR PROPOSED AID-FINANCED INPUTS, WHAT IS THE RATIONALE FOR AID FINANCING THE COSTS OF CONSTRUCTION OF ON-FARM DISTRIBUTION SYSTEMS, IN ADDITION TO THE CONSTRUCTION OF SECONDARY SYSTEMS AND APPURTENANT FACILITIES AT THE TANK SITES? ASSUMING THAT MOST OF THE COSTS OF CONSTRUCTING ON-FARM DISTRIBUTION SYSTEMS ARE IN FACT LABOR COSTS, THIS COMPONENT SHOULD BE A FARMER/VILLAGE CONTRIBUTION TO THE PROJECT OR, IF IT PROVES IMPOSSIBLE TO GENERATE SUFFICIENT FARMER SUPPORT DURING THE PROJECT DESIGN PHASE, AN RTG INPUT.

....B- ALTHOUGH THE APPARENT RATIONALE FOR AN AID-FINANCED IRRIGATION PROJECT IN THE NORTHEAST IS THE NEED TO MOTIVATE AN RTG INSTITUTIONAL INTEREST IN WATER UTILIZATION AS WELL AS WATER DEVELOPMENT, 80 PERCENT OF PROPOSED AID FINANCING IS FOR CONSTRUCTION WHILE ONLY 12 PERCENT OF PROPOSED AID FINANCING IS FOR THE COSTS OF PROVIDING TECHNICAL ASSISTANCE. USAID SHOULD CONSIDER ATTEMPTING TO MINIMIZE THE AID CONTRIBUTION TO CONSTRUCTION WHILE INCREASING THE LEVEL OF AID FINANCING FOR RESEARCH AND PROJECT ACTIVITIES ADDRESSED TO INCREASING THE LEVEL OF FARMER INVOLVEMENT IN THE IRRIGATION SYSTEM.

3

FINANCING RESEARCH TO INCREASE ITS UNDERSTANDING OF FACTORS WHICH PROMOTE FARMER COOPERATION AND VIABLE WATER USER ASSOCIATIONS; AIT, IN COLLABORATION WITH THE KASETSART UNIVERSITY SOCIAL SCIENCE FACULTY, IS REPORTEDLY INTERESTED IN CONDUCTING SUCH RESEARCH. IN PLANNING A RESEARCH COMPONENT, USAID SHOULD BE AWARE THAT THE ASIA BUREAU HAS PROPOSED AN INTER-COUNTRY EVALUATION OF IRRIGATION PROJECTS (IN BANGLADESH, INDIA, INDONESIA, PAKISTAN, THE PHILIPPINES, SRI LANKA), THE OBJECT OF WHICH WOULD BE TO GAIN INSIGHTS WHICH WOULD BE OF USE AGENCY-WIDE TO DESIGNERS AND PLANNERS OF SIMILAR PROJECTS IN THE FUTURE.

3. A NUMBER OF ADDITIONAL ISSUES WERE RAISED DURING THE COURSE OF APAC DISCUSSIONS OF THE PID. THE FOLLOWING CONCERNS ARE GERMANE TO PROJECT DESIGN:

....A- A CLEAR LINK BETWEEN PROPOSED PROJECT BENEFITS AND INTENDED BENEFICIARIES IS NEEDED. IN THIS REGARD, WHAT IS THE NATURE OF LAND HOLDING PATTERNS IN THE REGION? WHAT IS THE NATURE OF TENANCY? IN DEVELOPING BENEFICIARY LINKAGES, IT MAY BE IMPORTANT TO DEMONSTRATE WHETHER BENEFICIARIES ARE TILLERS OR LAND OWNERS. IF LAND OWNERS PREDOMINATE, DATA ON SIZE OF LAND HOLDINGS, ETC. WOULD BE DESIRABLE.

.. B- IT IS AID/W'S UNDERSTANDING THAT THE FORD FOUNDATION IS CURRENTLY SUPPORTING A MAJOR STUDY OF IRRIGATION IN IS CURRENTLY SUPPORTING A MAJOR STUDY OF IRRIGATION IN THAILAND AT CHIANG MAI UNIVERSITY WHICH HAS AS ONE OF ITS PURPOSES A COMPARISON OF RTG WATER USER ASSOCIATIONS WITH PRIVATE, FARMER-INITIATED ONES. IS IT ANTICIPATED THAT THIS STUDY WILL YIELD PERTINENT INSIGHTS IN TIME FOR CONSIDERATION IN DESIGNING THE SUBJECT PROJECT?

....C- DOES THE SOIL IN THE PROPOSED PROJECT IMPLEMENTATION AREA HAVE A SUFFICIENTLY HIGH SALT CONTENT TO SUGGEST THE NEED FOR DRAINAGE FACILITIES AS IS THE CASE IN THE LAM NAM OON AREA? IF SO, WILL THE FARMERS MAKE SUFFICIENT LAND AVAILABLE FOR DRAINAGE FACILITIES? IN VIEW OF SERIOUS SALINITY PROBLEMS ASSOCIATED WITH AID-FINANCED IRRIGATION PROJECTS ELSEWHERE, ESPECIALLY PAKISTAN AND AFGHANISTAN, THIS FEASIBILITY ISSUE SHOULD BE ADDRESSED EARLY IN THE PROJECT DESIGN PROCESS.

....D- IN VIEW OF THE HISTORY OF DISINTEREST IN AND HENCE DETERIORATION OF IRRIGATION FACILITIES IN THE REGION, IT IS AID/W UNDERSTANDING THAT THE FORMATION OF WATER USER ASSOCIATIONS AND LEVYING OF WATER USER CHARGES TO SUPPORT MAINTENANCE ARE PLANNED TO ASSURE THE CONTINUING INTEREST IN THE PROPOSED IRRIGATION SYSTEM ON THE PART OF AFFECTED FARMERS. HOW DOES USAID PLAN TO OVERCOME AN APPARENT RELUCTANCE ON THE PART OF THE THAI FARMER TO PAY FOR WATER?

....E- THE CURRENT FOCUS OF THE SUBJECT PROJECT ON RICE CULTIVATION DESPITE THE DIFFICULTIES OF GROWING IT IN THE AREA IS APPARENTLY THE RESULT OF A USAID VIEW THAT THE PRIMARY EFFECT OF INCREASED WATER AVAILABILITY WILL BE AN INCREASE IN RICE OUTPUT FOR CONSUMPTION BY PROJECT BENEFICIARIES. IN AID/W'S VIEW, THIS GOAL MAY BE TOO NARROW. USAID SHOULD EXPLORE AND PP SHOULD ADDRESS THE FEASIBILITY OF INCLUDING A SECONDARY CROP PROMOTION COMPONENT IN THE PROJECT FOR THE PURPOSE OF ENCOURAGING THE RAISING OF CASH CROPS WHICH MIGHT ENHANCE THE

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....F- ISSUE OF THE NEED FOR AN EA WAS RAISED DURING THE APAC BUT NO DECISION WAS MADE IN THIS REGARD IN VIEW OF BILL ACKERMAN'S ABSENCE BECAUSE OF HIS ATTENDANCE AT AN ENVIRONMENTAL SEMINAR IN THAILAND. UNDERSTAND FROM ACKERMAN THAT DURING SEMINAR IT WAS AGREED THAT EARLIER NEGATIVE IEE WOULD STAND AND THAT THERE IS THEREFORE NO NEED FOR AN EA IN CONNECTION WITH THIS PROJECT.

4. DESPITE USAID EXPECTATION, REF. A, THAT PROJECT COSTS WILL BE LOWER THAN ENVISIONED WHEN SUBJECT PID PREPARED, PC, IN ITS MOST RECENT REVIEW OF THE PID; REITERATED ITS CONCERN THAT PROJECTED OVERALL AID FINANCED COSTS PER FAMILY OF THE PROJECT ARE HIGH. DURING APAC DISCUSSION OF THE PID, DON COHEN INDICATED THAT IF THE PROJECTED RATE OF RETURN FOR IMPROVEMENTS ON A SPECIFIC TANK WAS NOT AT LEAST

TEN TO FIFTEEN PERCENT, IT WOULD NOT BE INCLUDED IN THE PROJECT. COHEN INDICATED THAT BECAUSE OF THE VARIABILITY OF BOTH COSTS AND RATES OF RETURN, FEASIBILITY STUDIES ARE PLANNED SERIATIM. AID/W CONCURS WITH VIEW THAT RATE OF RETURN SHOULD BE MINIMALLY TEN PERCENT ON ANY GIVEN TANK SLATED FOR IMPROVEMENT UNDER THE PROJECT. VANCE
BT

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ANNEX B.

AID 1020-26 (7-71)
SUPPLEMENT I

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

(INSTRUCTION: THIS IS AN OPTIONAL FORM WHICH CAN BE USED AS AN AID TO ORGANIZING DATA FOR THE PAR REPORT. IT NEED NOT BE RETAINED OR SUBMITTED.)

Life of Project: From FY 80 to FY 86
Total U.S. Funding: $ 9.2 MILLION
Date Prepared: JUNE 1980

Project Title & Number: NORTHEAST SMALL SCALE IRRIGATION PROJECT 493-0213

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: (A-1) To improve the quality of life of the rural poor.	Measures of Goal Achievement: (A-2) Poorer rural inhabitants of the Northeast receiving a greater proportion of increasing benefits from: 1. Continuing increase in areas cultivated and productivity of land. 2. Increase in cash earnings from cash croping. 3. Increased participation in local level decision making.	(A-3) Government statistical reports, general and specific.	Assumptions for achieving goal targets: (A-4) 1. Government policy continues to support programs in rural development and equity improvement. 2. General economic growth continues at sufficient rate.
Project Purpose: (B-1) Establish a replicable approach and institutional capabilities for increasing agricultural incomes for small farmers within command areas of existing tank irrigation systems in Northeast Thailand.	Conditions that will indicate purpose has been achieved: End of project status. (B-2) 1. Cropped area in wet season increases by a minimum of 100% to 14,000 hectares with cropping intensity of at least 125%. 2. Average net farm income increases by minimum of 70% to more than $1100 equivalent per household, with equitable distribution of benefits. 3. Training program for participating agency personnel and farmers based on project approach is instituted. 4. RTG plans to replicate approach in other sites.	(B-3) 1. Reports from RTG agencies active in the project. 2. Management information system reports. 3. Evaluation reports.	Assumptions for achieving purpose: (B-4) 1. Price structure for inputs/crops remains favorable and market demand attractive for project crops. 2. Farmers accept new techniques and risks associated with intensive agriculture. 3. Adequate labor available for dry season cropping. 4. Rainfall does not deviate drastically from average annual patterns during project. 5. RTG maintains commitment to rural areas of the Northeast and tank irrigation systems.
Outputs: (C-1) 1. Water delivery system rehabilitated/improved for seven sites. 2. O&M/Farm to market roads constructed. 3. Irrigation service centers established. 4. Water management and maintenance systems improved. 5. Agricultural support services and inputs adequately available at each site.	Magnitude of Outputs: (C-2) 1. Total improvements as follows: (a) Dams Install toe drainand filter (m) 3,485 Riprap and filter (1,000 m^3) 36 Regrade, compact and trim (100 m^3) 38 (b) Main and Lateral Canals Lining (km) 175 Canal enlargement (km) 45 Excavation (km) 75 Turnouts (ea) 480 Checks (ea) 120 Regulators (ea) 60 Cross Drainage Structure (ea) 60 Bridges (ea) 60 (c) Sub-Lateral Canals 430 (d) Drainage Ditches (km) 70 2. 175 km of laterite roads along main canals; 40 km of laterite roads along lateral canals. 3. 7 irrigation service centers equipped and operating. 4. (a) Water user groups trained and functioning in support of farmers needs at 7 sites, (b) RID maintenance crews at each site, (c) consultant recommended O&M plan adopted. 5. (a) 16 trained irrigated agricultural specialists, (b) 14 trained extension agents, (c) BAAC providing credit, (d) demonstrations at all tanks, (e) crop insurance program tested at all tanks, (f) market support plans and research carried out at all tanks, (g) 14 farmer observation tours accomplished, (h) linkage with seed multiplication project at all sites.	(C-3) Consultant and RTG reports, reviews and evaluations. Site visits.	Assumptions for achieving outputs: (C-4) 1. Social organizations of the villages will support self-help water users groups. Government irrigation policies will be consistent, clear, and stable. 2. Farmers will cooperate and assist with installation, operation and maintenance of ditches by providing labor and land as needed. 3. RID/DOAE establish cooperative relationship to carry out project. 4. Farmers accept new cultural practices needed for intensive agriculture.
Inputs: (D-1) RTG Budget for: Personnel stationed at tanks Extension program (DOAE) Research program (DOA) A&E services (RID) Construction contracts for main system (RID) Topographical survey (RID) Soil Survey (DLD) AID Funding for: Training Consultants Research support Crop insurance Educational/Publicity Program Construction of on-farm system Land preparation Evaluation Farmers: Labor Water use fees BAAC/Commercial Banks: Production credits	Implementation Target (Type and Quantity) (D-2) (See Financial Plan)	(D-3) Project records and vouchers (RTG and AID)	Assumptions for providing inputs: (D-4) 1. RTG personnel needs approved by civil service commission. 2. Budget needs approved by RTG. 3. Adequate numbers of trained, motivated persons found to work on project as consultants and technicians

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Annex C

Borrower/Grantee's Request for Assistance

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Annex D

Detailed Analyses Material

1. Technical Analysis (Agriculture)
2. Engineering Analysis
3. Social Analysis
4. Economic Analysis

ORGANIZATION AND TRAINING NEEDS FOR MEDIUM-SIZED IRRIGATION RESERVOIRS

Introduction

Numerous consultants from international banks, from research institutions and from aid organizations have cited the potential for using small- and medium-sized reservoirs for irrigation purposes in Northeast Thailand. Unfortunately, while more than 500 small, medium and large reservoirs and ponds have been built the full potential for use for irrigation has yet to be proven. In many instances the full potential cannot be realized due to the lack of necessary infrastructure. Yet, probably more importantly, the lack of proper operation and maintenance staffing and procedures has resulted in poor management of the water and has led to rapid deterioration of the systems. This poor management structure has discouraged adoption of irrigated agriculture such that very little of the potentially irrigated land under the medium-sized reservoirs is actually irrigated. In order to realize the potential of these reservoirs the management structure must be re-organized and the staff trained in operation and maintenance procedures. In addition, it is necessary to provide proper on-farm water management and agronomic extension services.

Staff Requirements

In order to manage a medium-sized reservoir in addition to a gatekeeper to operate the gate at the reservoir it is necessary to have management personnel at the main and secondary canal level as well as a water user group representative (common irrigator type) at the tertiary level of the system. There also must be a maintenance staff available both for preventive maintenance and regular repairs as well as for emergency repairs during the cropping seasons. Finally, it is necessary to have competent extension staff with training in irrigated agriculture and with a motivation to impact this training to the users of the system.

Obviously, unless the permanent staff are of sufficient quantity and have proper training it is not possible to manage and maintain the system. It seems necessary that, in addition to the gatekeeper, there is a minimum of two systems operations personnel coordinating the water demands from the main and secondary canals to the Chak outlets. If the system is very large there may be a requirement for additional operation personnel. Within the Chak there is a need for on-farm water management extension personnel as well as regular agronomic extension personnel. If the normal Chak is from 500 to 800 rai in area the on-farm water management and agronomic extension agents should be able to serve about ten Chaks. Yet even with this intensity of staff it is not going to be possible for the system to work effectively unless there exists a strong water users association including a properly trained common irrigator. The on-farm water management extension staff

will work very closely with these groups and help to train the common irrigators but it is probably necessary to also have one subject matter specialist (SMS) to help organize these associations initially. Finally, there must be a permanent maintenance crew stationed at each reservoir. Therefore for a system that has two main canals and serves from 20-24 Chaks the following staff are required:

Position	Number
Gatekeeper	1
System Operations Staff	2
On-Farm Water Management Extension Agent	2
Agronomic Extension Agent	2
Maintenance:	
Supervisors	1-2
Technicians	1-2
Laborers	4-6
Subject Matter Specialists*	
Water Management	1
Water Users Associations	1

If the system is larger additional staff will be required, but even if it is smaller this is probably the minimum staff required to manage the system. After the system is working properly and the common irrigators are well trained it will be possible to reduce part of the extension input assuming the regular extension agent from the tambon can provide some of the required services. The subject matter specialists will be rotated to another set of reservoirs once they have trained their respective staff and have established the necessary working procedures.

Staff Training

The majority of the young engineering technicians working for the Royal Irrigation Department (RID) have received their training at RID's School of Irrigation. The zonemen and common irrigators have a much less formal training program and thus are even less prepared for the demands of their position. Unfortunately, even this limited training is not very applicable to on-farm water management needs of the medium-sized reservoirs nor has RID shown much interest in improving the operation of these systems. Recent research has already demonstrated that there exists a significant gap between the needs of water users within the Chak and the schedule of releases followed by the gatekeeper.

In many instances the gatekeeper simply opens the gates or he waits for a specific request from a farmer. In either case the system

*To work on a number of systems depending upon location and scheduling.

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is not being operated optimally. The first individual that needs to be trained is the gatekeeper himself. He needs to learn something about plant-water requirements, irrigation delivery system efficiency and about the inflow/outflow patterns for his particular system. Once the gatekeeper understands the fundamentals of water demand than working closely with the operations staff, the water management extension agents and the water management subject matter specialist the supply side can be scheduled without too much difficulty. The formal training for gatekeepers should take about two-three weeks with another two weeks of on-the-job working with the other personnel in the system developing and modifying the tentative operation schedule. However, the gatekeeper must also learn to very carefully monitor the water flowing in the system as well as the water leaving the system in order to learn the unique characteristics of his reservoir system. This knowledge will allow him to modify his schedule from year to year as appropriate for that year's rainfall/runoff pattern.

The systems operations personnel have perhaps the most difficult set of tasks particularly if the system is operated so that water is rotated within the irrigated area. During each dry season given the amount of water stored the systems operations personnel are going to have to determine the limits of the system to be served. Within this system they are going to have to decide on the most efficient rotation system and are then going to have to see that the water is rotated to serve all the water needs of the users within the different Chaks. This is going to require very careful coordination with the other systems operation personnel, with the gatekeeper and with the common irrigators for each Chak. And, of course, the systems operation personnel will have to work closely with the maintenance staff in order to schedule maintenance so that it has the least impact on the use of the irrigation system.

The training for the systems operations personnel should include modules on crop-water demand, schedule rotation development, systems coordination, maintenance supervision, water management, drainage, irrigation techniques and farmers organizations. This training should take about eight weeks with about six weeks of formal training divided roughly into two week segments related to: (1) systems scheduling and operation, (2) water measurement, maintenance and drainage, and (3) irrigation techniques and working with farmer organizations. The last two weeks of training should be on-the-job training in their system where they put their training to use under close supervision both from the subject matter specialists and the concerned consultants.

The extension agents, both for the on-farm water management agent and the agronomic agent, must have specialized training in irrigation water management. In addition, the water management extension agents should have some idea about systems operations and drainage so they can explain the rotation and drainage systems to their farmers and also so they can help train the common irrigators. The training in on-farm water management should take about four weeks of formal

training and then there should be another two weeks of specialized training in systems and drainage operation. The final two weeks of training should include the common irrigators and, again, should be on-the-job practical training to begin to learn exactly what is required to operate their system within each Chak. The agronomic extension agents will need about two weeks of formal and informal training in market development and marketing.

The maintenance supervisors and technicians, in addition to their regular technical training, require training in maintenance scheduling and drainage repairs. They also need to have some knowledge of the operation of the system because they may need to slightly modify the distribution system where there are problem areas.

Training Materials and Sites

The regular extension training and zoneman orientation courses can be held at the normal sites as the location requires. However, the specialized training for the gatekeepers, the systems operation personnel, the extension agents and the subject matter specialists is going to require the development of a new training site. In the Philippines the National Irrigation Administration has established a center for training irrigation technicians (B.Sc. agriculture graduates) that has a one-year curriculum which includes systems operation, on-farm water management, maintenance scheduling and supervision and extension. Parts of this training course are applicable to the training needs for medium-sized reservoirs and an effort should be made to obtain all the training materials that are available from this center. The International Rice Research Institute (IRRI) in the Philippines organizes each year a 6-8 week training course in water management which is often run in conjunction with one of the IRRI rice production courses. The materials from both these courses should be obtained. In addition, as part of an RID-IRRI joint research project, a training course for training RID zonemen and watermasters in irrigated rice production and water management was organized in June-July, 1979 at Khon Kaen and Kalasin. The Thai language materials that were developed for that course are now with Khun Prasert Kanoksing at RID and if all goes as planned will be combined into a training manual in August, 1980. Tahal Engineering, as part of its Lam Pao contract with RID, has developed training materials for zonemen, common irrigators, and water user organizations. These materials should be obtained and evaluated for usefulness.

Probably the best site for the majority of the training is at the Experimental and Demonstration Farm for Irrigated Agriculture at Kalasin. This area receives its water indirectly from Ubol Ratana Dam via the medium-sized reservoir of Huey Sithon. Hence, the site can be operated as a reservoir irrigation system and therefore it is good for training gatekeepers, systems operation personnel and on-farm water management and agronomic extension agents. In addition, the farm itself has a controlled water delivery that is excellent for on-farm management instruction. Finally, hostel, classroom and dining facilities are available to accommodate the trainees and the staff. Other possible

sites include the Northeast Agricultural Research Center/Extension Training Center at Tha Phra, the Community Development Regional Training Center in Ubol, the Nong Wai Project Center outside of Khon Kaen, the RID facilities at Lam Pao Dam and perhaps at Huey Ang reservoirs outside of Roi Et. However, none of these sites have all the facilities that are available at Kalasin.

In order to make this program work the training should be a joint RID-Extension Department exercise. RID can provide some of the staff from the School of Irrigation particularly from the Department of Irrigation Engineering and Irrigation Agronomy as well as experienced staff from the RID regional centers such as Khun Nukul Tongtavee at the Khon Kaen RID Center. Extension can provide training personnel from the Tha Phra training center such as Dr. Thanya Terasart who is very interested in water user organizations. Extension and maintenance personnel from the NEA small-scale pumping schemes could also play a valuable role in the training. If approached through RID it might be possible to persuade someone such as Dr. Al Early from the IRRI Water Management Section to help organize and run the first training course building on his experience with the course he helped organize in 1979 at Kalasin.

Terms of Reference for

On-Farm Water Management/Agronomic Extension Staff

Much of the management of the system should be the shared responsibility of a water management and agronomic secialist assisted by Tambon Agents.1/ Since these specialists can best estimate the crop water requirements and the system's irrigation efficiency, they should schedule the water distribution and allocation. Their management and operational responsibilities are as follows:

1. - Water Management Specialist: His duties are similar to those of an irrigation engineer. He would assume responsibility for the conveyance, distribution and allocation of all water below the dam. Thus, based on both the crop and variety need, the cultivated area, and water availability, he schedules the distribution of water on a rotational basis such that each farmer receives his equitable share. Additionally, he must assure that the system efficiently conveys water, that the system allows precise water control, and that the water is efficiently utilized for crop production.

To achieve efficient water management he must project, from the available supplies both the potential wet season and dry season irrigable area and deliver the required amounts of water on a timely basis. This requires knowledge of potential evapotranspiration (Ept) and crop coefficients (Kc) for both rice and various upland crops, the system's delivery efficiency, the probability of rainfall and rainfall intensity, effective rainfall, soil permeability, and the soil field capacity (FC) and welting point percentages, etc.2/

This water management specialist must advise farmers on the amount of water to apply, when to apply, and how to apply within the limits of the rotational delivery system. Essentially he is in charge of the planning, operation, and

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1/ The number of Specialists and Agents on the tank system will be established at a ratio of 1:400 farm families, minimum.

2/ While most of the required information is not presently available for each tank, all except Ept, Kc, and precipitation probabilities can be determined by the water management specialist.

utilization of the irrigation system. He will consult and cooperate with RID engineers in the release and allocation of water particularly for irrigation (some tanks also provide water for city and village use), for flood control, in regard to maintenance and closure, and the duties of the zone man and water master concerning the opening and setting of gates and checks.

It is anticipated that system operation experience may dictate the need for changes, relocation, extension of channels and structures within the command area. The water management specialist must be able to design and supervise all additionally required construction. To assure continued efficient operation of the system he must advise on cleaning and maintenance procedures. In scheduling maintenance his maintenance request and needs must be complied with first.

Additionally, the water management specialist must understand and be able to fulfill the duties of the agronomic specialist listed below. Each of these specialists must be able to substitute for the other in order that supervision and assistance is always available at the command site.

To perform in this above capacity, this specialist must possess a command of the following disciplines: (1) surveying and mapping, (2) open channel design, (3) water measurement including conveyance, delivery, and application efficiency, (4) solid intake measurements, (5) calculation of crop water requirement - both rice and upland crops, (6) determination of soil textures, welting point and field capacity percentages, (7) meteorological measurements and interpretations, in terms of evapotranspiration, effective rainfall, (8) field irrigation techniques including application rates, etc., (9) moisture conserving cultivation practices (10) construction techniques, (11) principles of cleaning and maintenance.

2. - Agronomic Specialist: This specialist's duties concern the activities in the field. In particular his concern is soil and crop management but overlaps with the water management specialist in on-farm water management. In effect his duties are most closely aligned with those of an agronomist and soils scientist.

Specifically, he advises farmers on their cropping patterns and crop varieties recommended for both wet and dry season production. Recommendations should reflect present and projected market demands, farmers family requirements, soil and climatic suitability, and water utilization. The

latter refers to prefering those crops with shorter maturity periods and minimal water requirements in order to conserve water for greater dry season cultivation. Continuing, this specialist advises the farmer on planting date, seedbed and soil preparation, seeding rates and plant spacing, fertilizer and lime requirements and time of application, water requirements and application frequency and methods, use of pesticides and herbicides when required.

Additionally, this specialist must play a lead role in demonstrating to farmers the advantages of improved water management and agronomic techniques. He would select various progressive farmers with which to work on their land within the command site, establish demonstration plots with various crops, water, fertility and other management treatments which demonstrate their yield advantages. Sites would be so selected and marked to allow maximum exposure and information for other farmers in the command area.

To fulfill these duties the agronomic specialist must be knowledgeable in the following disciplines: (1) soil fertility and nutrient availability, (2) soil pH and liming requirements, (3) soil physics and soil physical properties including the role of organic matter in improvement of soil physical properties, (4) identification of crop disease, insect, and nutrient problems and their preventive and remedial treatments, (5) crop and variety selection and adaptability to the soil and climatic conditions, (6) plot design and layout, (7) extension techniques, (8) statistical analysis, etc. Additionally, the agronomic specialist must be knowledgeable in all disciplines required of the water management specialist.

Despite what appears as formidable subject matter requirements for these specialists, it is felt these responsibilities could be managed by selected graduates of a 5-year vocational agricultural curricula. Their field and classroom training would emphasize methodologies with but a minimum of theory. One of the primary products of the technical assistance would be a system's operational handbook which would outline in detail, step by step, the methods and procedures required in operating all phases of the system and which will srve as a guide in fulfilling their day-to-day job responsibilities. Additional assistance and advice will be available to them from the DOAE's regional water, soils, and crops subject matter specialists.

Their training as described elsewhere consists of a one year period of mixed classroom and "on-the-job" experience. At the end of this period, continued back up training and assistance will be available from the technical advisor on an "as-needed" basis. While both specialists will receive similar training, the difference will be in the intensity of their field application. The water management specialist field training will emphasize primarily water problems while the agronomic specialist will concentrate on soils and crops.

TABLE D1-1 - PRECIPITATION, PAN EVAPORATION, AND TEMPERATURE AT SEVEN TANK SITES

	Mean Annual Precipitation (mm)	Mean Annual Class A Pan Evaporation (mm)	TEMPERATURE (°C)		
			Average Monthly Mean	Warmest Monthly Mean	Coolest Monthly Mean
Huai Khi Lek	1,960	1,940	-	-	-
Huai Aeng	1,411	1,863	27.2	29.7 (May)	23.3 (Dec)
Phuttha Utthayan	1,495	2,154	26.5		
Huai Kaeng	1,376	1,863	27.2	30.6 (Apr)	23.6 (Dec)
Lam Chamuak	1,210	1,925	26.2	28.7 (Apr)	22.2 (Dec)
Huai Chorakhe Mak	1,300	2,273	27.0	29.6 (Apr)	23.4 (Dec)
Huai Talat	1,621	2,273	27.0	29.6 (Apr)	23.4 (Dec)
MEAN	1,481	2,041	26.9	-	-

TABLE D1-2 - General Characteristics of Tank Command Area Soils

No.	TANK	SOIL SERIES	CLASSIFICATION 1. USDA - 1970 2. National	SOIL TEXTURE	EFFECTIVE SOIL DEPTHS (cm)	COLOR PROFILE	STRUCTURE a. Upper A - horizon b. Subsoil	SLOPE (%)
1.	Huai Talat	Roi Et Loamy Variant	1. Aeric Paleaquults 2. Low humic gley soils	Fine sandy loam or silt loam over clay loam.	>150	Pale brown or brown with Reddish yellow or strong brown mottles over light Brownish grey with yellow brown or yellowish mottles.	a. Weak fine and medium subangular blocky. b. Strong medium and coarse subangular blocky.	0-1
2.	Huai Charakhe Mak	"	"	"	"	"	"	"
3.	Phuttha Utthayan	Roi Et (Mixed Series)	1. Aeric Paleaquults 2. Low Humic	Loamy sand, sandy loam over sandy clay loam or sandy clay.	"	Dark grey with dark brown and yellowish brown mottles over light brownish grey.	a. Weak fine and medium subangular blocky. b. Moderate medium to coarse subangular blocky.	0-3
		Korat	1. Oxic Paleustults 2. Grey Podzolic Soils	Sandy loam over sandy clay loam.	"	Very light grey or brown over brown or pale brown.	a. Weak medium subangular blocky. b. Moderate medium and coarse subangular blocky.	0-3
4.	Huai Aeng	Korat	"	"	"	"	"	"
		Ubon	1. Aquic Dystropepts 2. Hydromorphic Regalsols	Loamy sand over sandy loam grading to sandy clay loam below 80 cm.		Dark grey to very dark grey with dark yellowish brown mottles over light brown with strong brown mottles.	a. Weak subangular blocky or single grain. b. Moderate subangular blocky breaking to single grain.	0-3

TABLE D1-2 - (Cont'd)

No.	TANK	SOIL SERIES	CLASSIFICATION 1. USDA - 1970 2. National	SOIL TEXTURE	EFFECTIVE SOIL DEPTHS (cm)	COLOR PROFITE	STRUCTURE a. Upper A - horizon b. Subsoil	SLOPE (%)
5.	Huai Khilek	Korat	--------- Similar Characteristics as Korat Nos. 3 and 4 above ----------					
6.	Huai Kaeng	Roi Et	Same as No. 3 above.	Sandy loam over sandy clay loam.	>150	Same as No. 3 above.	a. Moderate fine and medium subangular blocky. b. "	0-3
7.	Lam Chamuak	Korat	Same as Korat Nos. 3, 4 and 5 above.	Same as Korat Nos. 3, 4 and 5 above.	"	Very dark grey or brown over brown or pale brown.	Same as Korat Nos. 3, 4 and 5 above.	0-3

TABLE D1-2 - (Cont'd)

No.	a. Drainage b. Permeability c. Surface runoff	Period of Water Saturation a. Surface b. Subsurface	Organic Matter 0-30 cm (%)	C.E.C. meq/100 grams a. 0-30 cm b. >30 cm	Base Saturation (%) a. 0-30 cm b. >30 cm	Available Phosphorus (PPM of P) a. 0-30 cm b. >30 cm	Available Potassium (PPM of K) a. 0-30 cm b. >30 cm	pH a. 0-30 cm b. >30 cm
1)	a. Poorly b. Slow c. Slow	a. 3-4 months b. Ground water level between 2-3 meters for 3-4 months in dry season	Very low 0.35%	a. Moderate low 6.75 b. Medium 14.1	a. Medium 47.0 b. Low 24.0	a. Very low 2.50 b. Very low 2.54	a. Very low 22.0 b. Low 39.9	a. 5.5 (5.0-6.5) b. 5.2 (4.5-6.0)
2)	"	"	"	"	"	"	"	"
3)	a. Poorly b. Rapid over moderate c. Slow	a. 20-30 cm of rain water impounded 3-4 mos. b. G.W. falls below 2-3 m in dry season	High 3.6%	a. Moderate low 5.2 b. Moderate low 6.1	a. Medium 36.8 b. Medium 48.7	a. Very low 0.6 b. Very low 0.6	a. Low 31.1 b. Low 44.9	a. 5.3 b. 5.3
	a. Moderately well b. Moderate c. Rapid	Ground water below 1 meter for most of year	Low 1.0%	a. Low 3.4 b. Low 3.5	a. Low 25.4 b. Low 33.5	a. Very low 1.9 b. Very low 0.6	a. Very low 24.2 b. Very low 23.8	a. 5.0 b. 4.9
4)	"	"	"	"	"	"	"	"
	a. Moderately well b. Rapid c. Slow	a. Rain water impounded 2-3 months b. Ground water level drops to 4-5 meters during dry season	Low 0.85%	a. Very low 1.1 b. Very low 1.2	a. Medium 48.6 b. Medium 42.6	a. Very low 0.52 b. Very low 0.83	a. Very low 21.8 b. Very low 21.0	a. 5.5 (6.0-6.5) b. 5.5 (7.5-7.8)

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TABLE D1-2 - (Cont'd)

No.	a. Drainage b. Permeability c. Surface runoff	Period of Water Saturation a. Surface b. Subsurface	Organic Matter 0-30 cm (%)	C.E.C. meq/100 grams a. 0-30 cm b. >30 cm	Base Saturation (%) a. 0-30 cm b. >30 cm	Available Phosphorus (PPM of P) a. 0-30 cm b. >30 cm	Available Potassium (PPM of K) a. 0-30 cm b. >30 cm	pH a. 0-30 cm b. >30 cm
5)	---------- Similar Characteristics as Korat Nos. 3 and 4 above ----------							
6)	a. Poorly b. Rapid over Moderate c. Slow	a. Rain water impounded up to 30 cm for 3-4 months b. Ground water level falls below 3 meters during dry season	Low 0.5%	a. Low 3.1 b. Low 7.6	a. Medium 49.4 b. High 76.2	a. Very high 46.9 (doubtful) b. Very high 62.7 (doubtful)	a. Very low 15.3 b. Low 49.3	a. 5.5 - 5.7 b. 6.4 - 6.9
7)	Same as Korat Nos. 3, 4 and 5 above	Same as Korat Nos. 3, 4 and 5 above	Low 0.5 - 1.0	Same as Korat Nos. 3, 4 and 5 above	Same as Korat Nos. 3, 4 and 5 above	a. Low 5.4 b. Moderately low 6.7	a. Very low 18 b. Very low 19.3	a. 5.5 - 6.0 b. 5.2 - 5.5

Table D1-3 - Cropping Recommendations for Field Crops

Crop	Growing Season	Crop Duration (Days)	Nursery Period	$N-P_2O_5-K_2O$ Kg/ha	Planting Method	No. of Irrigations	Cultural Practices	Average Yield Mt/ha
Rice: RD-1 RD-2	July-Nov	<140	4 weeks starting mid-June	60-60-40 split nitrogen	Sow nursery in beds. Transplant at 15 cm. x 15 cm.	Maintain 5 cm. water level	Puddle Soil 2-3 times in June. Cultivate 3-4 times.	4.06
Rice: RD-5	"	<160	"	"	Sow nursery in beds. Transplant 15 cm. x 20 cm.	"	"	4.00
Rice: N. Sanpathong	July-Dec	>160	5 weeks starting in June	40-30-20 split nitrogen	Sow in nursery. Transplant 20 cm. x 25 cm.	"	"	3.5
Rice: RD-1, RD-2	Jan-May	<140	4 weeks starting mid-Dec.	60-40-20 split nitrogen	Sow in nursery. Transplant 15 cm. x 15 cm.	"	"	5.0
Corn: Super Sweet	Monsoon Dry season	65 75-80		46-20-25 split nitrogen	Plant in ridges, 2-3 seed/hill	2-4 at 2-4 week intervals	Weeding 4 times. Drain in monsoon.	25,000 green cobs
Sorghum: Early Hegari	Dry season Feb-April	85-90		90-90-60 split nitrogen	Plant in ridges 50 cm. x 15 cm.	4 irrigations at 2-4 week intervals	Weeding 4 times. Ratooning possible.	3.0-4.0

Table D1-3 Continued

Crop	Growing Season	Crop Duration (Days)	Nursery Period	$N-P_2O_5-K_2O$ Kg/ha	Planting Method	No. of Irrigations	Cultural Practices	Average Yield Mt/ha
Peanuts: Tainan No. 9 Tainan No. 6 SK 38	Dry season			20-60-40 preplant	Spacing 50 cm. x 15 cm.	4-6 light irrigations	-	1.6-3.0
Soybeans: S.J.-2	Dec-April	90-115	-	20-40-40	Plant spacing 50 cm. x 20 cm. 2-3 seed/hill	4-5	Inoculate seed.	1.9-3.1
Cotton: Delta Pine BTK-12	Nov-April	150-160	-	75-75-40 split nitrogen 3 applications	Plant on ridges 100 cm. x 45 cm.	3	10-12 spraying for pests	1.9-2.8
Jute: JRC-321 Burma	Mar-June	90		50-50-25 split application	Plant spacing 30 cm. x 10 cm.	Flood one month after sowing + 2 more light	Thin to 10 cm. 3 weeks after sowing. Weed out ridge 2 times	1.9-2.5
Mungbean: M-7-A	Nov-April	85-90		20-60-40 preplant	50 cm. x 20 cm. on ridge. 30 cm. x 20 cm. on flat beds.	3	Thin, weed, hoe and ridge	1.9
Sweet Potato: D.S.-Huey Sithon W.S.-Guatemala	Nov-May	120		50-50-100 preplant in dry season	Plant on ridges 100 cm. x 30 cm.	2-3	Lift vines	

Table D1-4 - Area Under Cultivation in Hectare within Each Project Area According to Crop Types and their Percentage (Dry Season) (Percentages are given within brackets)

Cultivated Area / Project Area	Total Area Cultivated	Area Under Rice	Area Under Oil Seeds	Area Under Water Melon	Area Under Sweet Corn	Area Under Vegetables	Area Under Kenaf	Area Under Others	Total Area Cultivated as a % of Rainy Season Cultivated Area
Huai Talat	5.79 (100.0)	5.76 (99.53)	- -	- -	- -	- -	- -	0.03 (0.47)	2.42
Huai Chorakhe Mak	16.59 (100.0)	16.35 (98.55)	- -	- -	- -	0.08 (0.48)	- -	0.16 (0.96)	16.09
Phuttha Utthayan	6.96 (100.0)	0.80 (11.50)	- -	1.02 (0.15)	3.48 (60.06)	1.49 (21.46)	- -	0.16 (2.30)	5.29
Huai Aeng	20.47 (100.0)	2.93 (14.43)	2.92 (14.24)	8.64 (42.14)	4.88 (39.41)	0.74 (3.61)	0.32 (1.60)	0.04 (0.19)	14.11
Huai Khi Lek	13.65 (100.0)	1.12 (8.21)	3.28 (24.04)	0.40 (2.93)	1.22 (8.95)	5.56 (40.78)	1.76 (12.90)	0.31 (2.20)	14.38
Huai Kaeng	9.38 (100.0)	- -	8.32 (88.68)	0.88 (9.40)	0.08 (0.85)	0.06 (0.67)	- -	0.04 (0.43)	9.32
Huai Lam Chamuak	22.76 (100.0)	- -	14.84 (65.20)	- -	- -	1.04 (4.57)	0.48 (2.11)	6.40 (28.12)	15.70
Total:	95.60 (100.0)	26.96 (28.29)	29.36 (30.71)	10.94 (11.44)	9.66 (10.10)	8.97 (9.38)	2.56 (2.68)	7.14 (7.47)	7.42

Table D1-5 - Average Yield of Paddy and the Different Varieties (Mt/Ha.) For Each Tank

Paddy Variety / Project Area	TNG	RNG	TG	RG	Mixed	Weighted Average
Huai Talat	1.9	2.0	-	-	0.4	1.9
Huai Chorakhe Mak	1.7	1.5	1.2	1.3	1.1	1.6
Phuttha Utthayan	1.6	1.5	1.5	1.7	0.9	1.6
Huai Aeng	0.4	1.1	0.7	1.6	1.7	1.2
Huai Khi Lek	1.4	1.5	1.7	1.5	1.3	1.6
Huai Kaeng	2.5	3.3	1.5	1.5	1.2	1.5
Huai Lam Chamuak	2.1	2.4	2.2	2.6	0.3	2.0
						1.6

TNG = Traditional Non-Glutinous Variety
RNG = Recommended Non-Glutinous Variety
TG = Traditional Glutinous
RG = Recommended Glutinous

PART 2 ENGINEERING ANALYSIS

A. Irrigation System

1. Existing Situation

The seven tank systems included in the Project were all constructed as part of an RTG tank construction program which began in 1951. Since the program began, 181 tanks have been completed ranging in capacity from less than one million cubic meters to as much as 35 million cubic meters. Of these, 146 are primarily for irrigation and 35 for domestic water supply.

For a number of reasons, discussed more fully elsewhere in this PP, the irrigation potential of the tanks has not been fully realized. Not the least of these is the fact that the irrigation system infrastructure has never been completed at any of the tanks. An essential component to a successful project is to complete these systems so that every irrigator can get water where and when (at least during the wet season) he needs it.

The seven project tanks have drainage areas ranging from 62 to 180 square kilometers giving them enough inflow to provide for at least 80% of the supplemental irrigation needs during the wet season except for Huai Chorakhe Mak, which has only enough for about 56%.

The percentage of the potential irrigable area which is being effectively irrigated is shown in Exhibit D2-1. There appears to be little relationship between the amount of runoff inflow to the tanks and the area actually being utilized for irrigation in the projects. For example, Huai Talat has the highest runoff amount but is actually irrigating only 21% of the potential area. This compares to Huai Chorakhe Mak which has a very low runoff but has one of the higher utilization rates at 56%. There seems to be, however, a high correlation between the percentage of the existing canal systems which is lined versus the rate of utilization as is illustrated in Exhibit D2-1.

From the descriptions given in the AIT feasibility study, it would indeed seem to be the case that the effective water delivery is limited to the lined reaches of the canal. Most of the unlined portions suffer from being washed out, being filled with sediment, having excessive

seepage losses, or being damaged by livestock crossing or wallowing in the canal.

Even in the area covered by the lined portions of the canals, however, there are problems of too few turnouts and lack of distribution systems other than paddy to paddy flow. Many illegal turnouts have been dug through the canal dikes, but the effective irrigation is usually limited to the area nearby the main and lateral canals. There does not appear to be a strong tradition of cooperation via the paddy to paddy approach as is found in a few other Asian countries and the downstream farmers complain that their upstream neighbors are often unwilling to release water to them when they need it.

2. Recommended Improvements

The recommended improvements to the irrigation infrastructure include rehabilitation of the embankments, repairing and extending the lining on the main and lateral canals, constructing more turnouts, adding more cross drainage culverts and drainage inflow/outflow structures, constructing checks and regulators in the canals, building more bridges for people and livestock crossings, designing and constructing a complete on-farm distribution system, providing for laterite surfaced roads along the main and lateral canals, and designing and constructing a service center building at each of the tanks. Scale drawings of each of the seven sites with canal improvements sketched in are included in Appendix One of this Annex.

a. Embankments

Generally the embankments are being adequately maintained by RID and for only three of them are any improvements suggested (See Table II-1). Even these improvements are not critical to the stability and safety of the embankments and, consequently, it is not necessary to the integrity of the Project that these improvements be made in the immediate future. RID may wish to schedule the suggested improvements according to their regular maintenance schedule.

b. Main and Lateral Canals

In most of the systems, the main canals had been designed and constructed to adequately cover the desired area. Some new laterals need to be added but primarily

what is needed is to rehabilitate the main and lateral canals by excavating the areas which are filled with silt and fill in, compact and trim the sections where flood flows and cross drainage have washed out the dikes or scoured the channel making it too wide and rough.

Lining is recommended for all the main and lateral canals for the following reasons: 1) these are light, sandy soils and the leakage losses in the unlined reaches have been observed to be extremely high, 2) these light soils also scour badly during times of excessive flows resulting in canals sections which are too wide and rough and are hydraulically inefficient, 3) because of a generally low priority for maintenance, the effective life of the unlined canals has been quite short, and 4) it is more difficult for farmers to make illegal turnouts when the canal is lined. Typical drawings showing the dimensions of the lining are shown in Exhibit D2-2. Lining is the largest single RTG budget item for the infrastructure improvement, but AID belives that it is essential for the development of a maintenable system. It can be seen from the existing situation that the only effective irrigation being done in these systems is from the lined sections.

A large number of structures must be added to the mains and laterals to make the system effective. Typical drawings of the structures are shown in Exhibit D2-2. For better control and distribution of the water, enough new turnouts will be added to reduce the distance between them to an average of 300 meters instead of the existing 400 to 500 meters. There will be a number of check structures built in the canals in order to stop the flow of water and to raise its level. Additional regulating structures will be provided at the critical junctures of the canals. Many more cross-drainage culverts and drainage inflow/outflow structures will be constructed and in some cases the natural drainage ways will be enlarged. Cross drainage has been one of the major problems on the systems, causing washouts, scouring, and sediment build ups. Where the canal goes through a cut section and there is considerable flow into the canal from the adjoining high ground, interceptor ditches will be provided to divert these flows to the nearest culvert. A number of wooden bridges spanning the canals will be built to eliminate the damages done by livestock climbing up and down the canal sides.

The AIT feasibility study recommended that laterite-surfaced roads be constructed alongside the main and lateral canals to allow for easier access for maintenance and, in some cases, to provide better farm to market access for the farmers. AIT specified four-meter wide roads along the main canals and three-meter wide roads along the laterals. AID agrees that a surfaced roadway is essential alongside the main and lateral canals to provide for better maintenance, but there is some question as to whether roadways of these widths are necessary unless they are also utilized as a farm-to-market road. AID believes that in most cases a narrower roadway sufficient for a motorcycle would suffice. Since this is a costly item on the RTG funding side, it is suggested that the roadway width requirements for each system be reassessed during the detailed design phase.

c. On-Farm System

The most pressing need on all of the systems is to improve the on-farm distribution of the irrigation water once it leaves the main and lateral canals. As mentioned before, no provision was made in the original RID designs for the provision of teriary, quaternary and on-farm canals and drainage so that the individual farmer can control the flow of water to his plots. This was not an oversight on the part of RID, but, in fact, it was the policy at that time that the farmer should be able and willing to finish the system. This was an almost universally held concept in Asia for many years but it has now been recognized to be invalid in most cases.

The Project will provide for sub-lateral canals served by the turnouts on the main and lateral canals which will carry water to an area ranging from 100 to 300 rai. From these sub-lateral canals, which will be a triangular, unlined ditch, ranging in top width from one-half to three fourths of a meter, will emanate sufficient smaller ditches to carry water to, and from, each farmer's land. In order to accomplish this, particularly in the steeper sections, it will be necessary to do some rearranging of the parcels and their bunds, to do some minor land leveling and to provide adequate drainage to all areas. It is impossible to predict the exact amounts and costs of this on-farm development without having the detailed topographic surveys[1/] the land classification, and the detailed designs. However, the unit costs are correlated with the various slopes occurring in

1/ The topographical maps will be at least to the scale of 1:5000 with a contour interval of 25 CM. The surveys should be done with a plane table and should define all the rice field boundaries as well as the existing watercourses and drainage ways.

the systems and are well substantiated by projects now underway - notably the Chao Phya Irrigation Improvement Project. The distribution of slopes and the cost extensions are given in Exhibit D2-3. The final project costs, of course, will be based upon detailed designs.

d. Maintenance

The maintenance facilities at the tanks are inadequate and underfunded. There are not enough technicians, laborers or vehicles and there is hardly any budget for materials. AIT recommends that each maintenance crew have a technician in charge, two inspectors, and a laborer for each two kilometers of main or lateral canal. They also specify, two motorcycles and one vehicle per site as well as increased budget for materials. AID fully agrees that upgrading the maintenance capability at each tank is essential to prolonging the life of the system and will urge RID to increase its maintenance budget. On the other hand, maintenance of the main and lateral systems will be greatly facilitated by the completed lining, by the provision of access roads, and by improvements in the drainage system. Also, with the addition of two full-time extension agents to each system, there will be much more pressure on the maintenance crews to perform.

AID recommends and AIT agrees that RID should be responsible for maintaining the embankments, the main and lateral canals and the major drainage ways while the farmer groups should be responsible for maintaining the sub-lateral canals and the on-farm systems. This should be made clear to and agreed to by the farmers at the outset of the project. But until a viable farmer organization is in place, RID may have to assume responsibility for maintaining the whole system temporarily if farmers efforts initially fall short of minimum maintenance requirements.

e. Service Centers

As a final item of infrastructure, a service center building will be designed and constructed at each tank. These centers will be primarily to provide offices for the two extension agents to be stationed at each tank and to provide a meeting place for the various farmer activities, such as Water User Group meetings and for training and instruction to be offered by the extension services.

The buildings will be simple concrete slab and concrete block structures with minimum furnishings and an outside latrine. A sketch and cost breakdown for the structure is contained in the Financial Annex.

3. Technical Analysis of Water Balance

AIT did a suitably rigorous water balance analysis for each system based on average rainfall and evaporation values. The pertinent data used in the water balance is shown in the Technical Agricultural Analysis.

As can be seen from Exhibit D2-4, the outlooks for substantial amounts of dry season cropping are not promising, and for Huai Chorakhe Mak, only a 56% capability is predicted for the wet season. It is AID's belief that this analysis by AIT is on the conservative side. AIT assumed an overall irrigation efficiency of 40% which is a good figure to use for the present situation. However, with lined mains and laterals and with improved irrigation practices, this efficiency should increase. The total acreages which can be irrigated would increase considerably with an efficiency of 60%. Experience in the past has shown that these efficiencies are attainable under good management.

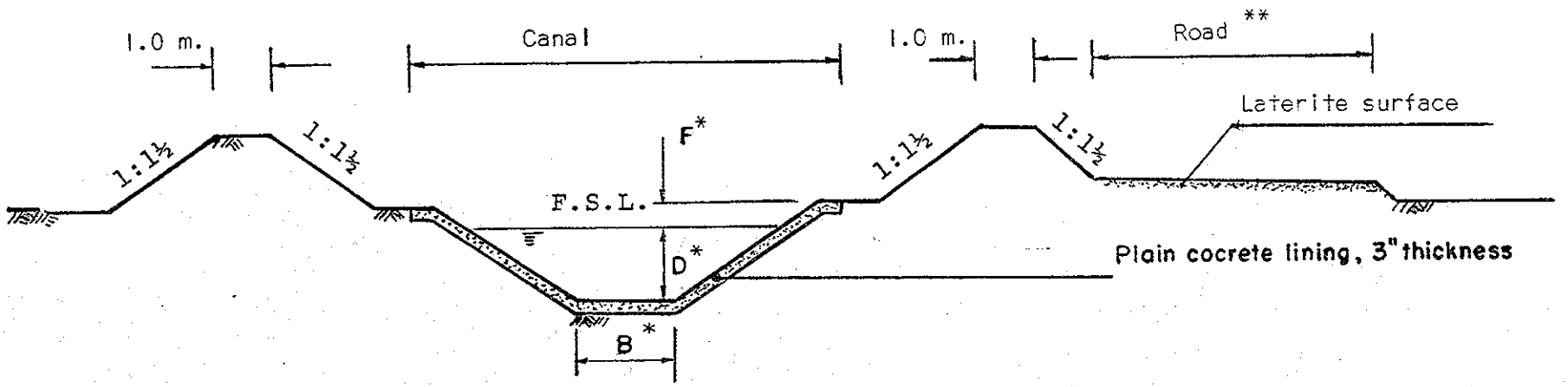
Other practices can be improved to save water. For example, at four of the tanks, the rice planting begins in June even though the wet season usually begins in May. Exhibit D2-8 demonstrates that the water requirement is reduced considerably if the planting is begun a month earlier. In the case of Huai Chorakhe Mak, moving the planting date to May and increasing the rice mix of long duration and short duration varieties from 50% - 50% to 40% - 60% respectively, the water requirement is reduced enough to enable the irrigation of an additional 1,000 rai in the dry season. With the provision of an assured water supply for irrigation in May, this change could most likely be implemented.

Condition of Existing Irrigation Systems

Tank	Drainage Area (Km^2)	Active Storage (Mm^3)	Inflow to Tanks (Mm^3/Yr)	Potential Irrigable Area 1/ (Ha.)	Area Effectively 2/ Irrigated in 1979		Length of Main and Lateral Canals (Km.)	% of Mains and Laterals Lined
					(Ha.)	% of Potential		
Huai Talat	153.0	18.53	69.71	2,240	480	21	40.30	23
Huai Chorakhe Mak	96.3	20.35	31.76	2,000	1,120	56	30.05	67
Phuttha Utthayan	62.0	14.56	25.60	2,560	770	30	18.50	11
Huai Aeng	147.5	21.00	46.63	3,070	1,840	60	22.75	65
Huai Khilek	80.6	22.20	43.52	1,440	420	29	30.15	19
Huai Kaeng	149.0	35.22	46.61	2,400	960	40	41.96	65
Lam Chamuak	180.0	22.19	43.56	2,160	1,410	65	22.30	65
TOTALS	706.4	154.05	307.39	15,870	7,000	44	206.01	45

1/ Irrigable area within command of present system as designed.
2/ AIT estimate.

Exhibit D2-1



* *Variable*

** *4 m. width on main canals; 3 m. width on lateral canals.*

TYPICAL CANAL SECTION WITH ROAD

Exhibit D2-2

Land Preparation Costs

Tank	Area vs. Slope			Costs (US$1,000)			
	0-2% (Ha.)	2-4% (Ha.)	4-6% (Ha.)	0-2% Slope	2-4% Slope	4-6% Slope	Total
Huai Talat	2,240	0	0	347.2	0	0	347.2
Huai Chorakhe Mak	1,120	0	0	173.6	0	0	173.6
Phuttha Utthayan	2,095	145	0	324.7	90.6	0	415.3
Huai Aeng	3,040	0	0	471.2	0	0	471.2
Huai Khi Lek	930	380	130	144.2	237.5	162.5	544.2
Huai Kaeng	1,790	465	145	277.5	290.6	181.2	749.3
Lam Chamuak	1,490	240	0	230.9	150.0	0	380.9
TOTAL	12,705	1,230	275	1,969.3	768.7	343.7	3,081.7

Unit Costs Used: 0-2% slope - $310/ha. for one-half the area; 2-4% slope - $625/ha.; 4-6% slope - $1,250/ha.

Exhibit D2-3

Recommended Irrigable Area with Improved Systems

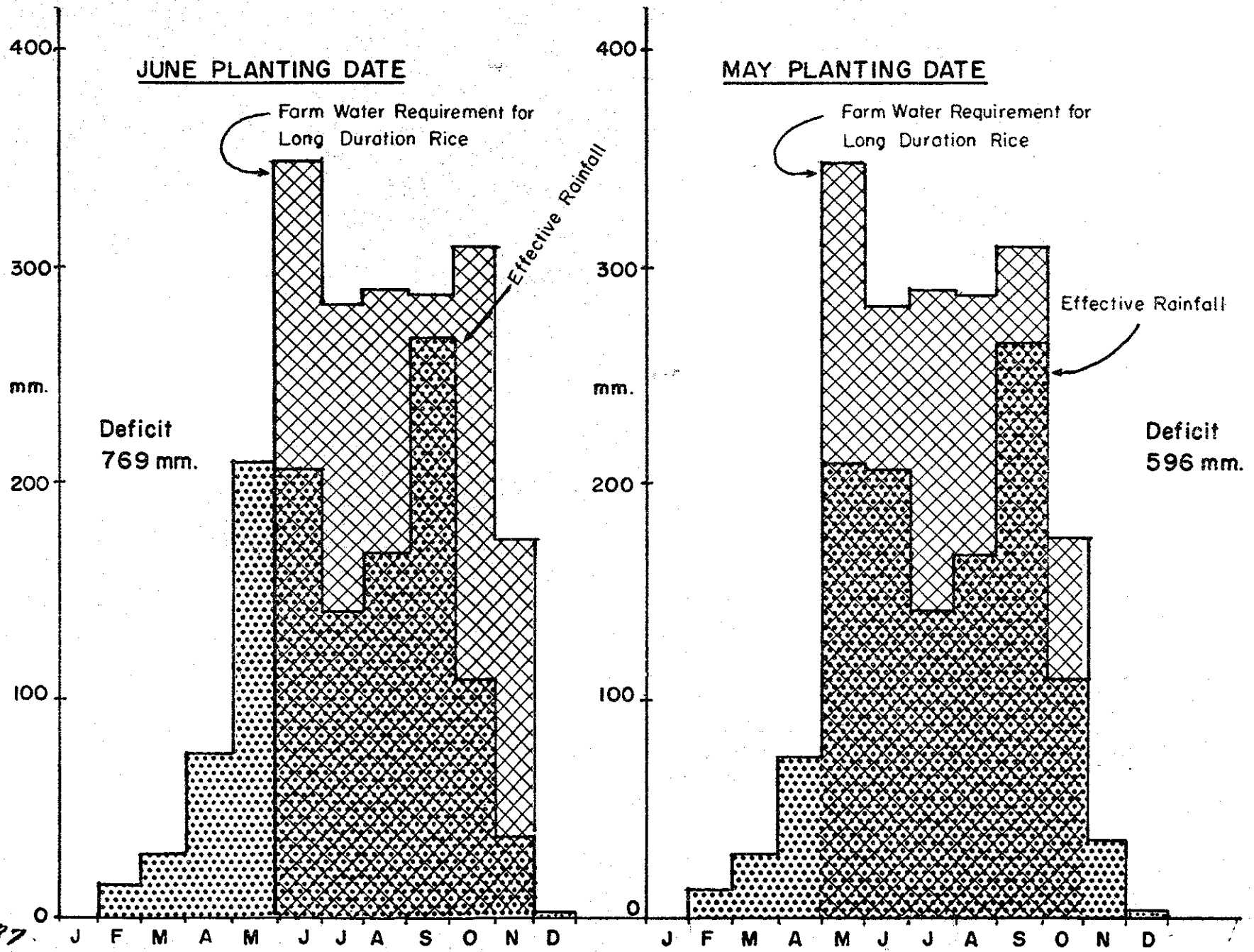
Tank	Potential Irrigable Area (Ha.)	Recommended Irrigable Area with Improved System (Ha.)			% Potential Irrigable Area Recommended by AIT		Start of Planting (Month)
		Wet Season		Dry Season	Wet Season	Dry Season	
		1/	2/				
Huai Talat	2,240	900	1,340	880	100	39	June
Huai Chorakhe Mak	2,000	450	670	160	56	8	June
Phuttha Utthayan	2,560	900	1,340	0	88	0	May 1/ June 2/
Huai Aeng	3,070	1,220	1,820	1,250	99	41	May
Huai Khi Lek	1,440	580	860	1,440	100	100	May
Huai Kaeng	2,400	960	1,440	1,600	100	67	June
Lam Chamuak	2,160	690	1,040	0	80	0	June
TOTALS:	15,870	5,700	8,510	5,330			

1/ Long duration rice

2/ Short duration rice

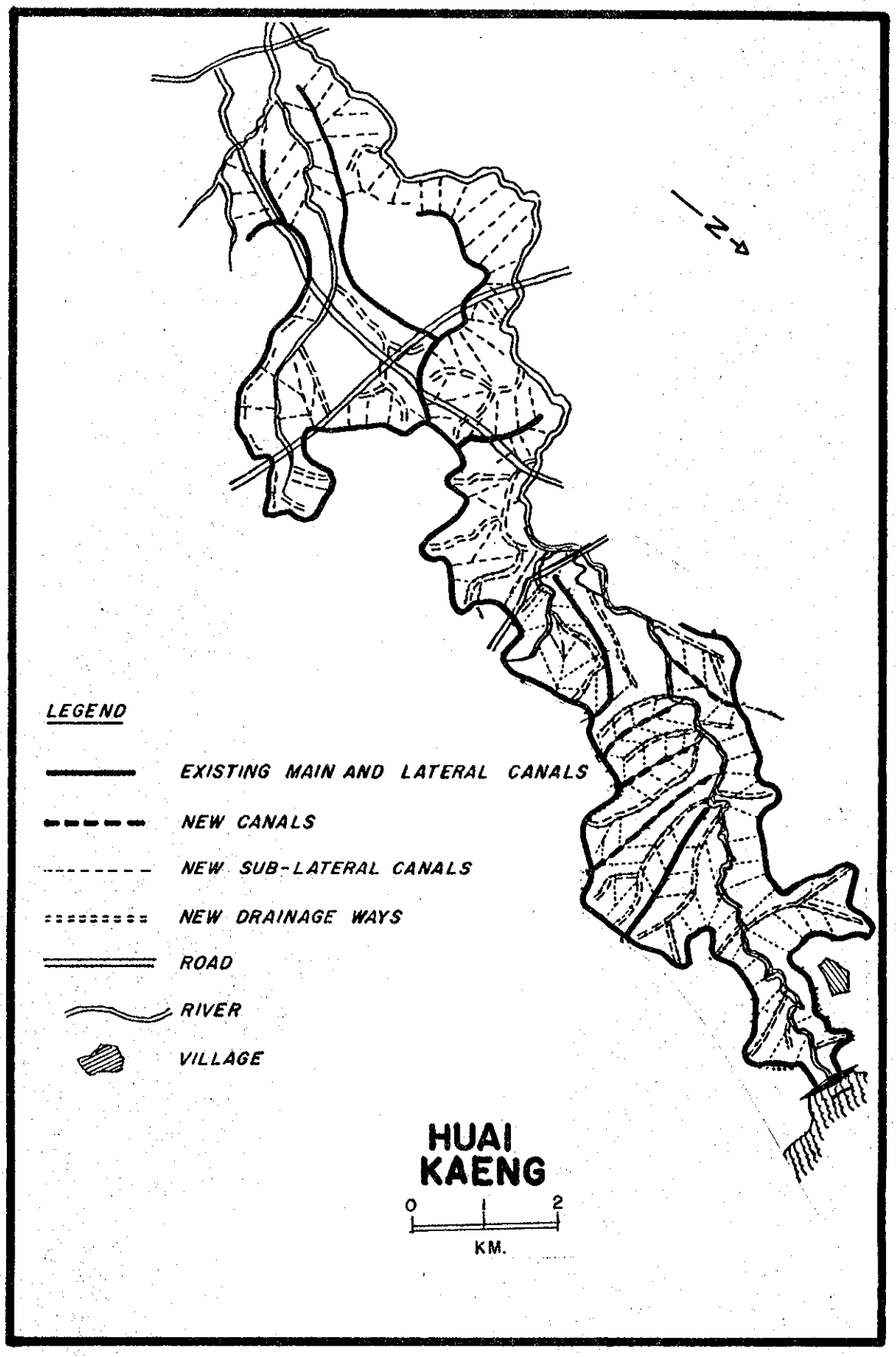
Exhibit D2-4

SAVINGS IN FARM WATER REQUIREMENT BY SHIFTING PLANTING DATE - HUAI CHORAKHE MAK



For an irrigable area of 1120 ha. this would be a savings of 1.94 $Mm.^3/Yr.$

Exhibit D2-5


N
LEGEND
EXISTING MAIN AND LATERAL CANALS
NEW CANALS
NEW SUB-LATERAL CANALS
NEW DRAINAGE WAYS
ROAD
RIVER
VILLAGE
HUAI KAENG
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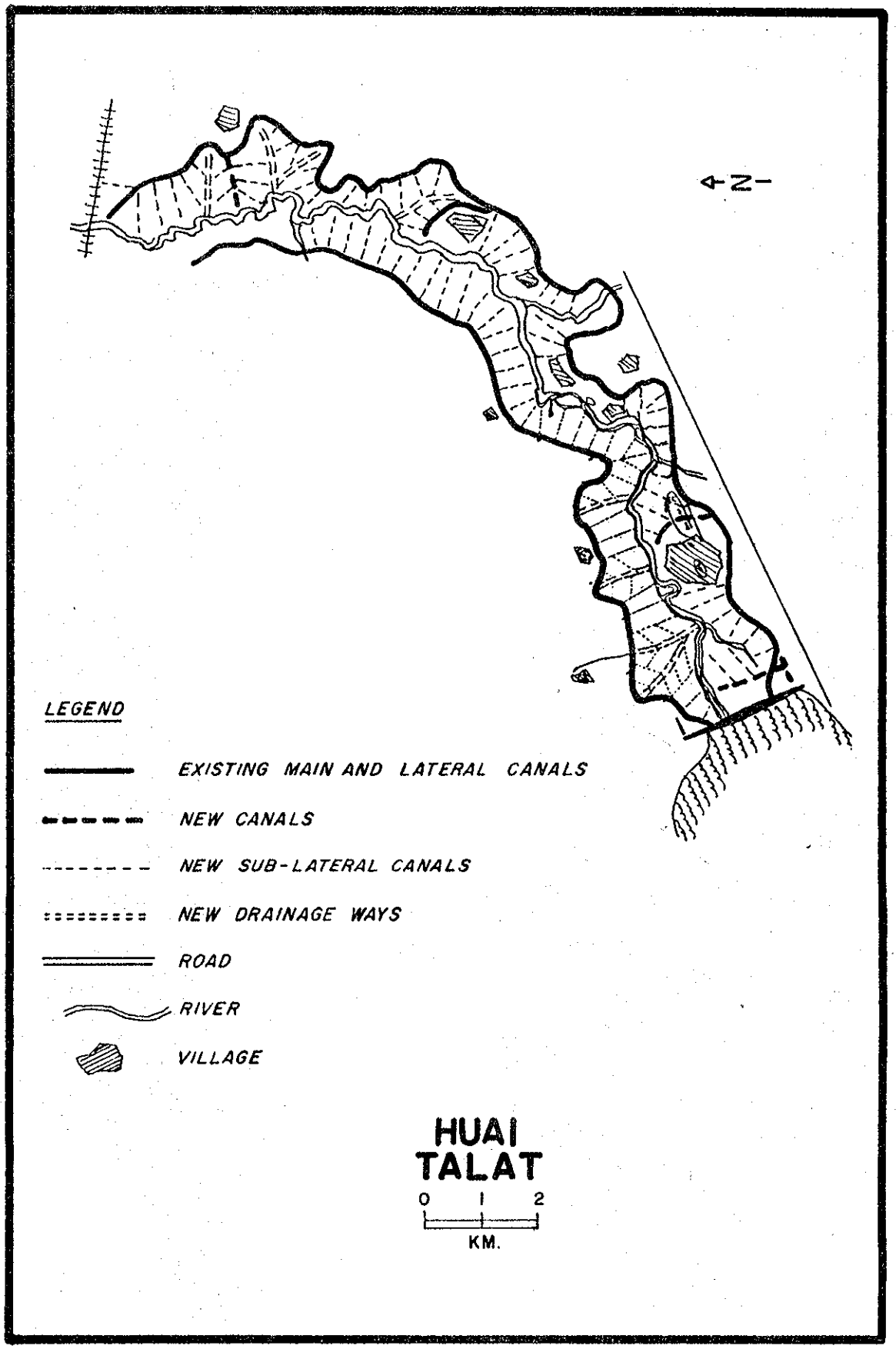
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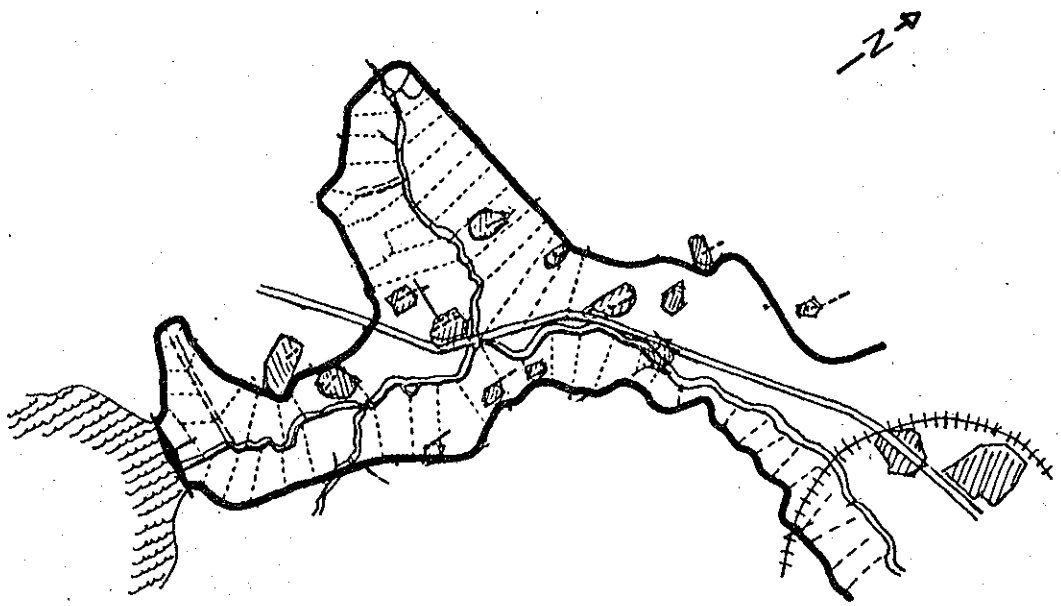


LEGEND

EXISTING MAIN AND LATERAL CANALS

NEW CANALS

NEW SUB-LATERAL CANALS

NEW DRAINAGE WAYS

ROAD

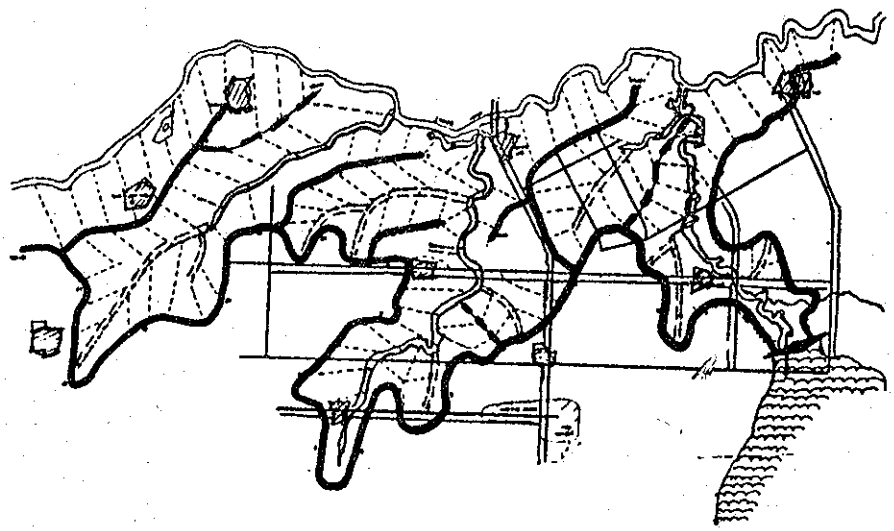
RIVER

VILLAGE

HUAI CHORAKHE MAK

0 1 2

KM.



LEGEND

EXISTING MAIN AND LATERAL CANALS

NEW CANALS

NEW SUB-LATERAL CANALS

NEW DRAINAGE WAYS

ROAD

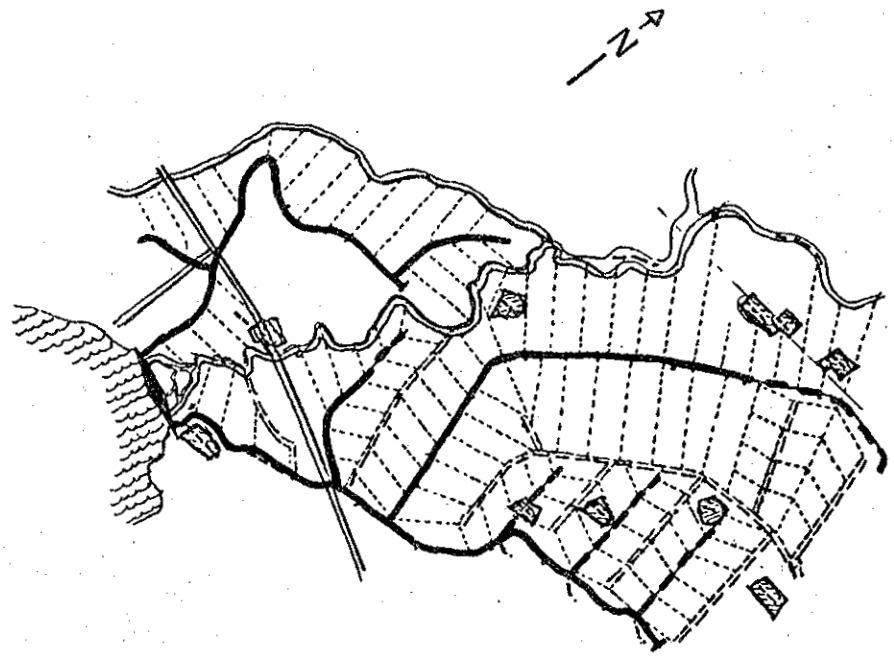
RIVER

VILLAGE

HUAI KHI LEK

0 1 2

KM.



LEGEND

EXISTING MAIN AND LATERAL CANALS

NEW CANALS

NEW SUB-LATERAL CANALS

NEW DRAINAGE WAYS

ROAD

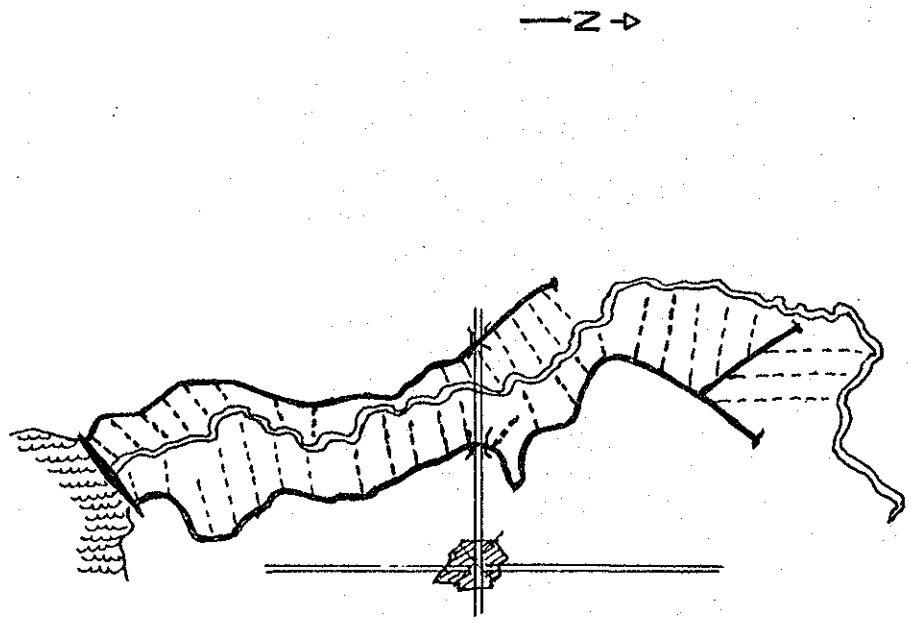
RIVER

VILLAGE

HUAI AENG

0 1 2

KM.



LEGEND

EXISTING MAIN AND LATERAL CANALS

NEW CANALS

NEW SUB-LATERAL CANALS

NEW DRAINAGE WAYS

ROAD

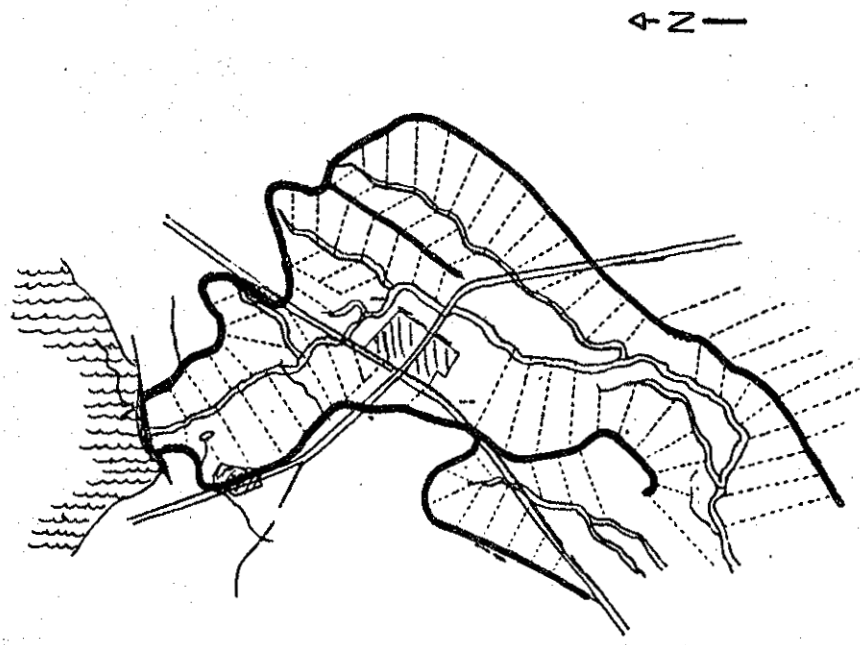
RIVER

VILLAGE

Lam Chamuak

0 1 2

KM.



LEGEND

EXISTING MAIN AND LATERAL CANALS

NEW CANALS

NEW SUB-LATERAL CANALS

NEW DRAINAGE WAYS

ROAD

RIVER

VILLAGE

PHUTTHA UTTHAYAN

0 1 2

KM.

ANNEX D.

PART 3 - SOCIAL ANALYSIS

A. Beneficiaries: Present Characteristics

The beneficiaries of this project are some 40,000 people living within the potential service area of seven medium-scale irrigation dams in Northeast Thailand. Culturally, the population of these service areas is in the main Northeastern Thai (Lao-Isan) but some Cambodian-descended peoples are also involved in some of the southern-most areas. The majority of the population can speak serviceable Central Thai language (the Cambodian-descended peoples seem to insist on speaking it with outsiders, even though many of them are also fluent in Lao-Isan). The vast majority (99%+) are Buddhists although a few Christian families can be found.

In terms of education, the beneficiaries approximate recognized Thai education profiles, although some interesting anomalies exist. For example, while only 90% (of those past primary school age) have not completed fourth grade (literacy level), nearly 30% have studied beyond the fourth grade (more than the national figure). Heads of household, however, usually in their mid-forties, only average about 5 years educational attainment.

The beneficiaries population shows the fertility rates that have characterized the Northeast in the recent past (Table 1). About 29% of the population is age 10 and under, average household size being 7.3 persons (average household labor force is 5.0 adult equivalents). Also, the 11 to 20 age bracket contains a further 29% of the population, indicating that there are likely to be serious land shortage problems over the next ten years unless intensification occurs. This points out the timeliness for the present project. While average farm size among beneficiaries (about 35 rai) ought to be able to support a somewhat expanded population if yields are increased through irrigation, irrigation is not being effectively utilized despite the nearby water supply.

It is instructive to compare the beneficiaries population with the average (rainfed agricultural) population of the Northeast in more detail. To do this three variables have been chosen: land value, gross crop sales, and off-farm income (Table 2). A fourth variable, as a proxy for income, is the household sum of off-farm income and gross sales. This approximates average net income (which includes in-kind income) but may be 15 to 20% lower in actual baht figures than the more laboriously computed net annual income. Table 2 shows that on most dimensions of comparison, the beneficiaries of the project are not now much better off economically than their rainfed-agricultural neighbors. Allowing for an inflation factor and using the data quoted in the 1980 CDSS, and assuming that the 4th variable in Table 2 is a surrogate for about 50% of real net income,* we can posit that any household below the surrogate income of ฿8,000/year/household (7.3x1,800x 1.2x.5) is below the level of "absolute poverty" as defined by the World Bank. From the last section of Table 2, then, we can assume about 57% of the beneficiaries population is in this group, compared with 64% of the "outside" population nearby. This is near the accepted percentage of rural Northeasterners in "absolute poverty" (60%). It seems reasonable then to assume that the project is indeed targetted on an appropriately needy population. The one glaringly anomalous statistic is land value. Why land within the project area should be valued so much higher than outside land may reflect more the aspirations or preconceptions of the owners than real productivity value (compare land value with crop sales in Table 2), or it may reflect the surveyor's opinions about the value of irrigated land.

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*(c.f. economic analysis. Surrogate average is about ฿10,500 whereas overall average net income is about ฿20,000 (฿15,000 net farm income plus ฿5,000 off-farm). Surrogate does not have farming costs subtracted out to get net sales income, but does not include income, but does not include income from cottage industries, livestock, income in kind, i.e. home consumption, etc.).

Table 1

Beneficiaries Population Age Distribution*

Age (Years)	% of Population
0 - 5	14.6
6 - 10	13.9
11 - 15	15.7
16 - 20	13.3
21 - 25	8.5
26 - 30	5.4
31 - 35	4.1
36 - 40	4.6
41 - 45	4.8
46 - 50	4.8
51 - 55	3.1
56 - 60	3.0
61+	4.2
	100.0

(Average Household Size = 7.3 persons).

* (Not computed by sex, but sample population did show approx. same number of males and femals, 49.4% males, 50.6% females).

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Table 2

Comparison of Project Beneficiaries with Those Nearby But Outside the Project Area (i.e. with Typical Northeastern Rainfed Farmers)*

SELECTED VARIABLES

Values of Household Variables for Comparison	% of Households in Variable Range	
	Beneficiaries	Outsiders
Land Value (Baht)		
0 - 10,000	9	18
10,000 - 30,000	15	29
30,000 - 60,000	21	19
60,000 - 100,000	20	15
100,000 - 150,000	17	12
150,000 - 250,000	9	4
250,000 +	9	3
	100	100
Gross Crop Sales (Baht/Yr.)		
0 - 100	13	19
100 - 2,000	25	25
2,000 - 5,000	22	23
5,000 - 10,000	25	22
10,000 - 15,000	5	5
15,000 - 20,000	3	3
20,000 - 30,000	5	2
30,000 - 40,000	2	1
	100	100
Off Farm Income (Baht/Yr.)		
0 - 1	46	40
1 - 2,000	18	15
2,000 - 5,000	14	23
5,000 - 10,000	9	12
10,000 - 30,000	10	6
30,000 - 260,000	3	4
	100	100

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Table 2 (Cont'd)

Off-Farm Income Plus Gross Crop Sales (Baht/Yr.) 1/	% of Households in Variable Range: Beneficiaries	Outsiders
0 - 1,000	5	11
1,000 - 3,000	18	14
3,000 - 5,000	16	21
5,000 - 8,000	18	18
8,000 - 15,000	21	22
15,000 - 30,000	15	10
30,000 - 260,000	6	5
	99	101

1/ (Computed another way: Among beneficiaries the bottom 40% average 2,600 ฿/Household, the top 10% average 54,000 ฿/Household; among outsiders the bottom 40% average 2,300/฿/Household, the top 10% average 51,400 ฿/Household.)

* Based on Sample surveying by AIT, Project beneficiaries for this Table defined as anyone holding land within the potential irrigation service area, even if most of their land is elsewhere. Outsiders defined as having no land at all within potential irrigation service area.

Table 2 also shows that in crop sales, the project beneficiaries are already doing somewhat better than their neighbors (e.g. 40% sell more than ฿5,000 worth of crops a year, versus 33% for the outsiders), but this is somewhat made up for by the outsiders in off-farm employment among "middle" income families (฿2,000 to ฿5,000 range), although the poor groups are again at a disadvantage. The last section of Table 2, however, shows that these discrepancies between beneficiaries and outsiders are not as serious as they seem: except for the very poor and the well-off who both fare somewhat better inside irrigation areas, the others make up for crop income with off-farm income and vice versa. Von Fleckenstein (1980) reached similar conclusions in comparing irrigated and rainfed farmers in the Northeast: the rainfed farmers had to work harder but their incomes were quite similar.

In terms of income stratification, the data in the footnote of Table 2 reveal two very important pieces of information. First, surrogate income is much more stratified than one might expect of rural Northeastern Thailand - the idea of the fairly uniformly poor Northeastern rural village seems to be contradicted by these findings. The top 10% of the households have about 20 times the average household income of the bottom 40%. Certainly some of this, but probably not most of it, is explained by differences <u>among</u> rather than <u>within</u> the various irrigation areas (see data in economic analysis). Second, stratification of beneficiaries population is quite similar to that of the nearby "outsiders," indicating that it is <u>not</u> the presence of irrigation per se that explains the unexpected degree of stratification. This raises questions about project feasibility and effects on the various groups (discussed below).

That the beneficiaries group may indeed have high hopes for irrigation and thus value their land more highly is reflected in attitude surveying conducted in the various areas. The vast majority of those expressing an opinion did see the advantages of irrigation for increased yields, labor saved, and livestock and fish-raising opportunities.

Of the beneficiaries population, the median age of the household head is 46 years. 95% are men (husbands). Women household heads were usually wives whose husbands were not present or occasionally daughters of former household heads. 92% of the household heads surveyed characterized themselves as fully occupied in agriculture. 5% said they were part-time farmers and only 3% did not farm. Nevertheless, only 26% of the households surveyed did not have someone working off the family farm for at least part of the year. 86% of the household heads worked their own (owned) fields, whereas about 11% used others fields free of charge (a common example is parents allowing children this privilege), and only about 3% had to rent land or mortgage their land. Finally, it may come as a surprise to many to discover that the majority of farmers in these areas not only do purchase and use fertilizer, but they invest quite a bit in it and use it on their subsistence (rice) crops.

B. Feasibility: Considerations

Of the beneficiary households surveyed by AIT (excluding here only those whose holdings were entirely outside the potential irrigation survey area) well over half had at least some amount of wet season irrigation. Furthermore, nearly two out of six had at least some amount (greater than 5% of their total farm area) of dry season irrigation as well. Nevertheless, the project sites were chosen because in each case the water in the system was not being fully utilized in either the wet or the dry season. Why, then, are people not using all the water they might? Situations vary from site to site but a general discussion is possible. On the average farm of 35 rai, 23 rai are cultivated in the rainy season, 5 rai are cultivated in the dry season, 4 rai are non-agricultural land, and the remaining 3 rai are left unclutivated for various reasons. Of those that use at least some wet season irrigation, the average irrigated area is about 17 rai (median = 15). In the dry season, the average irrigated area (of those that have at least 1 rai, i.e., other than kitchen gardens) is 3 rai (median = 4). This indicates that expansion of dry season irrigation may not be a problem of physical infrastructure. Of those with access to water in the wet season, well less than half (about 36%) use dry season irrigation and of those that do, they vastly reduce the amount of land they crop, compared to the amount of irrigated land they use in the wet season. A seasonal reduction in water supply alone cannot explain this vast reduction: it is clearly evident at the site that in nearly all cases vast amounts of water remained in the reservoirs at the end of the dry season.

Table 3

DRY SEASON IRRIGATION AND INCOME*

3A. WHO DOES AND DOES NOT USE DRY SEASON IRRIGATION, IN RELATION TO INCOME:

	Very Poor (5,000฿/hh)	Poor (5-10,000฿/hh)	Better Off (10,000+฿/hh)
No real irrig. (Kitchen garden only)	28%	16%	17%
Irrigation (>1 rai)	13%	8%	18%

3B. OF THOSE USING DRY SEASON IRRIGATION, WHO USES MORE, IN RELATION TO INCOME:

	Poor (10,000฿/hh)	Better Off (10,000+฿/hh)
Low Irrigation (1 to 4 rai)	32%	18%
Medium to High Irrigation (> 4 rai)	22%	28%

*Surrogate income used: cropsales plus off-farm income (see Table 2). The associations implied here in Table 3 are significant at least the .04 level (Chi Square) in a single 9 x 8 matrix (63 degrees of freedom, 242 cases total).

The statistics become even more compelling when one focuses on the poorer farmers whom the project aims to assist. Table 3 makes the point. The statistics summarized in this table support results of non-structured field interviewing. In the villagers' opinions, "other poor don't irrigate in the dry season" (opinions for why this was the case varied according to who was asked - the better off farmers said the poor were lazy, poorer farmers saw themselves facing a plethora of insurmountable obstacles many of which they couldn't understand; some blamed var.ous others, etc.).*

All in all, four main potential problem areas exist for greater and more effective utilization of irrigation: physical infrastructure, organization (especially of irrigation), inputs, and marketing. The problem areas are also interconnected with each other, thus solutions are not necessarily specific to particular individual problem areas. While added and improved physical infrastructure (mainly canals and roads) will reduce or eliminate physical constraints, the statistics cited above indicate clearly that this alone will not mean that the area actually irrigated in the dry season will significantly increase, nor will farmers, especially poorer farmers, be certainly benefitted. Were the data available, it is likely that a significant part of the average 13 out of 28 rai cropped but not irrigated in the wet season would also evidence problems other than physical infrastructure. We will thus narrow the discussion here to constraints on organization, inputs and marketing, and especially their social aspects.

1. Organization

Many studies in Northeast Thailand have shown that a principal problem in irrigated areas is the quantity and especially timing of water delivered to the fields. This is predominantly true of the project area also. During non-structural field interviewing, it was apparent that

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*It is recognized that an association between poverty and non-irrigation does not prove direction of causality. In the present case, we can be fairly certain of mutual effect, actually of the "viscious circle" variety.

farmers in the beneficiary population are rather bewildered by the subject of irrigation organization. Most seemed to think it was something the government did, not they themselves. They were quite surprised to hear about the high degree of locally initiated and controlled irrigation organization existing in parts of North Thailand. The organizational functions they did perform themselves were not perceived by them as being organized. Instead they characterized them either as just "helping each other out" or else individual participation for direct individual interest. For example, in describing how shared farm ditches were maintained, one farmer answered people just helped each other, another said everyone took care of only the section fronting his own property, another said that downstream farmers only came up to work on the ditch (by themselves) if the water wasn't getting through. In most cases if disputes arose that could not be settled between the parties involved, the WUA only served as a conduit to bring the problem to the attention of the chief irrigation official who would usually (probably wisely) base his decisions on precedent (i.e., status quo ante). In part of one irrigation area farmers stated the village headman settled disputes - in their view they used to have a WUA but it had been disbanded.

The single case found (during the few days interviewing) where disputes were settled by farmers rather than officials thus occurred where a WUA did not even exist. What then is wrong with the WUA's? In the AIT survey, a majority of farmers thought the WUA was inefficient and a vast majority thought WUA members could not agree on what to do when faced with problem, that various groups competed and conflict existed. On the other hand; most felt that WUA rules should be enforced strictly (and were not), that a WUA leader should be elected, that water allocation was necessary and that there should be a system to allocate it. A significant minority did not even recognize that WUA had any rules at all, yet, two to one, farmers, interviewed expressed their hopes for WUA by saying that WUA membership should be compulsory. They were more divided on such topics as whether or not water rotation would help solve conflicts and whether or not WUA should expand its activities beyone irrigation management per se.

Various researchers have pointed out problems with irrigation organization in Thailand. AIT (1978) cited the lack of support for WUA's by the Royal Irrigation Department but other research points in a different direction. In studying irrigation organization effectiveness in North Thailand, Vanpen et al (1979, in Thai language) found that organizational effectiveness resulted when the farmers themselves ran the system, made the rules, selected the leaders, took part in building the system, etc., and that the effective organizations were small and administratively easy to manage. Gillespie (1975), Srifunya and Early (1980) and others (e.g. Thanya) have independently reached the same conclusion.

The major problem with WUA's is that they are far too big, often many hundreds or even more than a thousand households in one organization. The more ideal size would be about 50 households or, less a size in which participatory decision-making and problem-solving could be expected to occur. The logical organization of this size would be along a farm ditch, which, according to several farmer's opinions serves 10 to 50 farmers. Table 4 points out the difficulty, however, the majority of farmers have plots in different locations, thus would need to be members of more than one farm ditch group at a time, creating a network instead of solid groupings. The solution to this dilemma must be found locally, by farmers themselves. A number of alternatives are possible. First, in areas where the majority on a ditch have primary interest in the plot on that ditch, an effective group might be organized. Second, land consolidation has been demonstrated to raise productivity in Thailand (Jerachone 1980) and may be feasible if locally desired, through informal trading, compensation system, etc. The key point here is that the method chosen must be selected locally in order to fully succeed. If organization by farm ditch group is impractical, other alternatives are available (subvillage, neighborhood, area where fields located regardless of ditch, etc.). Gillespie (1975) supports focusing on the farm-ditch level, pointing out that this level has the greatest potential for effective local leadership. His paper has many useful suggestions for initiating such organization.

The organization of irrigation also will have to vary with the size of the system. In each case (Local variation), it must be clear what responsibilities are at each level, and these must be feasible to the organization charged with carrying them out. The organizational issue is flagged here as the key item for investigation and follow-up by the project technical assistance team. A social anthropologist or rural spciologist would be the appropriate advisor to deal with this matter further on a full-time basis throught the life of the project.

2. Inputs and Marketing (and Credit)

The key item of feasibility, concern with inputs and marketing is profitability, in both a narrow and wide sense. In the narrow sense, the Baht return to the farmer must be sufficient for him to choose to expand cropping instead of pursuing other alternatives. This is necessary but not sufficient. In the sider sense, the farmer's accounting system will include many factors not readily quantified nor easily discernable to others. For example, one farmer stated that he was dissatisfied with the prices offerred by the merchant he dealt with. When asked why he did not look for another merchant, the following considerations emerged in a lengthy discussion. First, the merchant had a virtual monopsony in the area and the farmer doubted it could be broken. Even if he went to another merchant, he could not be certain the merchants were not in collusion with each other. The merchant treated him well in other respects, for example, giving him instantaneous loans in emergencies. Turning elsewhere would jeopardize this relationship, perhaps meaning that a sick child would not be able to receive medical treatment at a later date if an emergency illness occurred. So many of these factors the farmer perceived as beyond his own control. What he could do himself, however, was to limit the amount of those cash crops the merchant would buy from him and pursue other options instead, which was what he did.

What can the project, then, hope to do about profitability in this wider sense? A number of options are possible, but the choice of option and the number of strategies adopted will influence success. If pared down too far success will be difficult (keep in mind that if

Table 4

Potentially Irrigable Plots
per Household
Frequency Distribution

# of Potential Irrigable Plots	% of Households in Survey
1	37
2	37
3	15
4	8
5	3

it were easy the farmers would have done something about it already). The basic strategy would seem to be to help provide for as many as possible of the farmer's wider concerns through other channels than he currently has access to while at the same time strengthening his ability to deal himself with the concerns remaining. For example, to reduce the various kinds of risk the farmer faces, he will benefit from some form of partial crop insurance and emergency loan credit fund. These are administratively simple to run and could be organized locally using group guarantor methods. To increase his own bargaining ability as well as lower his costs, purchase of inputs and volume sales are also likely to help. Such techniques should logically fit in with water user organization at the farm ditch (or other small-scale level) but could also be promoted in other ways depending on the local situation. Local organization will also help to get a sufficient number of farmers cropping in the same place at the same m time. Water is more likely to be provided on time to such a group, labor exchange helps out, marketing is easier, etc.

A key methodology is one of better communications. Nearly all the factors discussed by Adul (1980) as influencing participation in irrigation are susceptible to improvement through better communications, i.e. such things as more frequent WUA meetings in smaller groups, more visits by extension agents, clear knowledge of water schedules from RID, farm-market newsletters (which should pay for themselves once organized) to inform farmers on market conditions, inputs available, etc. Transport may be a problem. The project can contact various truckers and make a list of their rates and farmers can go together in hiring a truck. A sufficiently energetic communications strategy, initiated, supported and advocated by the project, should go far in leading to appropriate local solutions to overcome the wider, less tangible problems of credit, inputs and marketing. The prestige of the government agency, its concern for wider interests, the backing of technical advisors - all these could go a long way in encouraging sufficient communications leading to the solution of local problems.

C. Feasibility; Effects

Given the generative rather than predetermined nature of this project it is difficult to assess the effects that may occur. Like all projects, it will depend on the skill, sincerity and hard work of the implementors. What we can attempt here, however, is a discussion of some of the likely stumbling blocks and suggest ways to cope with them.

In section B. above, some results of the AIT attitude survey were summarized. However, section A. showed that there is a great deal of variation in the beneficiary population, of particular concern here being variation in income and degree of seasonal irrigation utilization. In the present section then, we will examine the attitude survey as attitudes are or are not associated with this variation, to understand what it may mean for project strategy toward various groups. Several other findings will also be examined.

Among the various attitudes which did not differ appreciably no matter what the income level or degree of dry season cropping were feelings that WUA rules should be strictly enforced and WUA ought to elect leaders, plus all those discussed above that demonstrate farmers' awareness of the benefits of irrigation. Interestingly, another statistic which did not vary appreciately across income level was how many families did and did not take loans (an average 20% did). Some differences did appear in attitudes once the responses were stratified, however. These are presented in Table 5.

Table 5 suggests, although not at all conclusively, that two types of systematic variation may be occurring. On the one hand, the middle income group seems to stand out from the others while on the other, opinions seem to change with the degree of dry season irrigation utilization. Middle income earners generally seem to have more faith in WUA than others, perhaps hoping to expand their opportunities. The similarity between low and high income earners is probably not for the same reason. The poor, like the middle income earners think that those upstream (usually those better off than they?) are unfair to downstream

Table 5

Selected Results of Attitude Survey
Stratified by Income
and Dry Season Irrigation
Utilization*

Statement	Stratified by (variable)	Response by Stratification Level** (low)	(low mid)	(hi mid)	(high)
Upstream farmers reluctant to pass water	income	A	A	A	D
	dry seas irg	A	A	E	A
Rotation of water avoids conflict	income	E	A	A	E
	dry seas irg	A	A	A	A
WUA members usually pay for system upkeep	income	D	A	A	D
	dry seas irg	D	D	E	D
WUA membership should be compulsory	income	A	A	E	D
	dry seas irg	A	A	E	E
WUA doesn't enforce its rules	income	A	A	A	A
	dry seas irg	A	A	A	E
WUA works efficiently	income	D	A	A	D
	dry seas irg	A	E	D	D

* Surrogate for income = gross crop sales plus off farm income (see Table 2). Percentages corrected to exclude no answer/no opinion categories.

** A = majority in strat. level agreed, D= maj. disagreed with statement, E = about equal agree/disagree.

irrigation users, but they are more cynical about water rotation, WUA efficiency, and don't agree with paying for WUA, probably because they get little benefit from it. The high income earners don't see upstream users (themselves?) as selfish, they don't want WUA to be compulsory, they don't think people pay for it, they don't think it works efficiently. Presumably they are happy with things as they are and have no interest in strengthening WUA.

Along the dimension of degree of dry season irrigation, Table 5 seems to show that opinions change the more one irrigates in the dry season. The high users are not as enthusiastic about compulsory WUA membership, do not think it works efficiently, are not eager for WUA to enforce its rules.

If the above interpretations are meaningful Table 5 suggests that middle income groups are likely to be most enthusiastic about the project, high income earners and high irrigators may be rather reluctant, and the poor, while willing, are probably a little u realistic about what WUA might be able to do for them and how easily they can be helped.

For the implications for project implementation we turn to a few last findings. We have no data on the time spent in "off-farm" employment but we do know high income earners and high irrigators employ more labor, while field interviewing strongly suggested that local wage employment, within the same rural area, was a primary dry season occupation for the poor. All this together with the unexpected degree of socio-economic stratification found in the survey data implies that while middle income earners and middle irrigators will be likely to benefit most easily from the project, in order to involve the poor special effort will be needed and that if any opposition to project goals occurs, it is likely to come from the better off farmers, some of whom are apparently quite well-off indeed. The project strategy implications are not clear. A possible solution might be to interest the better off farmers in some sort of scheme that provides relatively high returns (in this case acceptably with relatively high investment) but requires little labor during critical times in wet or

dry season cropping, if indeed the main thing this group is likely to lose as a result of the project is cheap and abundant labor.

This issue is uncertain but is flagged here as an item of potential concern for the project implementation team.

D. Spread Effects

There will of course be some benefits to local inhabitants nearby the project area (secondary economic effects). Also if the local communications and organizational techniques prove successful they can be expected to spread rapidly through many areas of the Northeast, since the irrigation areas are nearly all on or very near major roads and are thus some of the least isolated places in Northeast Thailand.

The principal value of the project, however, in terms of spread, is its replicability throughout most of the irrigation areas of the Northeast. The underutilization of irrigation in the Northeast is not an isolated phenomenon, thus the opportunity for replication is quite large, eventually to perhaps as many as 15% of the population of the Northeast. Although the size of irrigation systems vary from quite large to quite small, many of the techniques to be developed and tested in the project can find real use in both larger and smaller systems.

E. Effects on Women, Migration, Fertility, Population

The project should result in greater on-farm employment and thus reduce rural to urban migration for both men and women. There seems to be nothing in this project that would benefit women more than men, but neither is there any evidence of the reverse. Women should be encouraged to participate in WUA and in the smaller group organizations. Whether or nor reduced rural to urban migration benefits women more than men depends on whether women migrate more from the Northeast than men (demographic figures in the project areas do not evidence this but it may be true of some age groups) and, ultimately, on value judgments concerning the status of women in urgan vs. rural settings.

Effects on population through fertility and displacement within the project areas are uncertain. Fertility, hopefully, will decrease as income increases and as farmers begin to see the effects of having to fit more adult population onto limited land resources. Judging from the population age profile (Table 1) this effects may become increasingly severe over the next decade or so. Local officials and development workers should compute a local population age profile and teach farmers what it will mean for them, both as a means of encouraging family planning but also as a means to generate interest in irrigation and agricultural intensification.

It is likely that population within project areas may effectively increase also as a result of attracting local outsiders to various types of employment, especially once incomes within project areas begin to increase. Effects of this type are certainly to be expected when projects are confined to particular scattered geographical settings with restricted resource access, an inevitable characteristic of irrigation projects in Northeast Thailand. The government can recognize these characteristics in its area development planning and endeavor to promote other types of projects in the area, targetted to benefit those without access to irrigation.

F. Effects on Environment

Analysis of environmental impact was not considered necessary for this project, since the project does not involve building any new dams or other major infrastructure. Rather, the improvement, extension and rehabilitation of existing physical infrastructure will result in an improved environment. Nevertheless, increased use of irrigation could present different types of environmental problems which should be mentioned here in order that project monitoring may be on the look out for them. Such sensitization will facilitate appropriate corrective actions if they are necessary.

While the use of irrigation in the dry season and to supplement rainfed wet-season farming farming should not lead to significantly increased health hazards

compared to present conditions, there are areas of health hazard associated with water in Northeast Thailand that are in need of attention. The cultural preference for (uncooked) fermented fish is one of the main reasons for the prevalence of liver fluke (opisthorchis viverrini) and intestinal in the Northeast. The supply of fish may indeed increase with increased water utilization, providing much needed protein and income, but the health hazards of consuming the fish uncooked should be stressed to the project area inhabitants.

Luckily, schistosemiasis has not been found in the target areas of Northeast Thailand. Poor drainage of irrigation water from fields and water ways can lead to increased disease vectors, such as mosquitoes, increased seivage pollution problems, increased soil salinity and concentration of chemical residues from farm inputs and adequate drainage should be designed into the Project.

Learning to manage and deal safely with an irrigation environment is certainly a feasible task. Northeasterners have long been accustomed to dealing with water problems in wet-season rainfed-flooded agriculture and small-scale dry season stream irrigation. Furthermore, the presence of hundreds of irrigation projects throughout the Northeast over the past three decades has provided an experience base that should insure that no unpleasant or unmanageable environmental problems are in store for the inhabitants of the present project areas.

Annex D4 - Economic Analysis

1. Project Economic Analysis: Farm Budget and Other Key Statistics

In the following section, summaries of the economic analyses of the individual sub-projects are presented. The potential wet season and dry season irrigable areas have been derived from the AIT engineering and technical studies. The estimate of the potential irrigable area in the wet season has been based on a 60:40 mix of HYVC to LDVs in all cases. For the dry season, the estimate of irrigable area is based on the water requirements of non-paddy crops notably, mixed vegetables and fruit, groundnuts and mung-beans.

Prices Used

In constructing the farm budget, the following financial (farm-gate) for the major inputs and outputs.

Inputs

Amonium phosphate	฿6/product kg.
Area	฿6/product kg.
Labor (wet season)	฿22/man day
Labor (dry season)	฿24/man day

Outputs

Paddy	฿2.5/kg.	
Groundnuts	฿5.75/kg.	
Mung Beans	฿5.80/kg	
Vegetables (wet season)	฿1,200/rai	At full develop-
Vegetables/Fruits (dry season)	฿1,800/rai	ment

The lower return on vegetables the wet season, reflects the fact that this refers to a rai of mixed vegetables only excluding fruits which offer high returns. Although some fruits can be grown in the wet season, conditions in the wet season are in general not conducive to their successful cultivation. They have, therefore, been excluded from the wet season farm budget.

The prices of other minor outputs have been taken from the results of the AIT survey and expressed in 1980 prices to conform with the above. In conducting the economic analysis, relative prices are assumed to be constraint over the 20 year economic life of the project. Paddy is the only

commodity which has been shadow priced for the economic analysis, since the farm-gate price is substantially lower than the FOB export price adjusted for transport, processing and handling costs. An economic price of ฿4/kg. is used. In the case of groundnuts and mung beans their financial prices approached close to world market prices.

Labor

Although there is undoubtedly some underemployment of labor during part of the year labor has not been shadow priced. Given the tendency for underemployed labor to seek off-farm work during slack periods, particularly in the dry season it is believed that the opportunity cost of labor does not deviate significantly from the respective seasonal wage rules. In addition, the project will lead to a significant increase in demand for both household and hired labor, reducing the incidence of underemployment. A combined total man-years of man-years of employment will be created annually in the project areas once they reach full development.

In most of the project areas the area under wet season paddy increases as fallow land is brought under cultivation. In most cases there is also a significant increase in dry season cropping. However, in Huai Phuttha Utthayan and Huai Lam Chamuak there is a slight decline in dry season cropping to allow for complete wet season supplemental irrigation over the wet season area. In both cases, although dry season cropping is not recommended, a small area of vegetable and fruits are included in the farm budget. In the case of Huai Chorake Mak there is a more significant decline in the level of dry season cropping even assuming a change in the current emphasis on dry season paddy to the recommended non-paddy crops. According to AIT engineers, the current level of dry season paddy cultivation in the sub-project area will anyway adversely affect the current wet seasons paddy crop by reducing the amount of water available. Thus some decline in the level of dry season cropping could be expected even in the absence of the project. However, even though cropping intensity does not increase in these cases, the project was still justified as a result of the increased in productivity of wet season cropping and any remaining dry season cultivation.

An indication of farmers capacity to pay the charges necessary to cover full O&M costs and the full cost of on-farm development has been made by including these charges at the end of the summary farm budget. (See notes on farm budget for details.)

In the farm budgets, all produce including that retained for home consumption, is valued at farm-gate prices.

The following notes apply to the summary farm budgets:

(a) Includes irrigable and non-rrigable areas within the project boundaries.

(b) Includes presently fallow land but exclude waste land and pasture.

(c) Includes small areas of groundnuts (wet season) tobacco, cotton sweet corn and sugar cane.

(d) Details on the production of vegetables/fruits and other crops such as sweet corn, are not included here but their value is included in the "Gross Value of Production".

(e) Includes an estimate of the net return from livestock, poultry and their products whether consumed on-farm or sold, and the actual return from fish raising and fish catching.

(f) Includes depreciation on agricultural equipment and interest on working capital. The increase in this item is due solely to the increase in the level of interest payments on production credit, the level of which will increase as a result of the project.

(g) O&M charges sufficient to repay full costs of O&M per year at full project development and capital cost charges sufficient to repay the full costs on-farm development over 15 years at 12% rate of interest assuming a three year grace period.

2. Project Economic and Farm Financial Analysis

For the project's economic analysis, the values of EIRR by tank and all 7 tanks combined were based on the farm budget data provided by the AIT survey of 1978/1979 crop year. The total estimated number of farm households for 7 tanks are 4,596 households. Incremental net farm income derived from net incremental income from rainy season, dry season, annual and perennial crops plus net other farm income. (Other farm income1/ minus other farm cost2/).

1/ Other farm income = income from livestock/fish/poultry, rental of equipment and land.

2/ Other farm cost = equipment depreciation, interest on working capital, explicit and inputed.

Investment costs were broken down into 5 main categories - rehabilitation cost, vehicles and equipment cost operation and maintenance cost, personnel and technical assistance plus 15% contingency on rehabilitation and vehicle cost, the total basic EIRR was 31.4 percent on the 20 year life of project as shown in Table D4-1. EIRR for each individual tank was computed in the same way.

For the farm financial analysis, the price of paddy of ฿2.5/kilogram was used instead of the shadow price $4.0/kilogram as in the project economic analysis. The series of Benefit/Cost Ratios for each individual tank were shown in Table D4.2.

Net present value of the flow of net income of 20 year period average s 49.8 thousand baht per farm or 33,713 thousand baht for all farms in the total 7 project areas. For each individual area the Table D4.2 also gives the detail.

Summary of Economic Analysis

Huai Talat

Impact of Rehabilitation

Wet Season Irrigable Area	14,000	Rai
Dry Season Irrigable Area	5,500	Rai
Paddy - Target Yield: LDV	535	Kgs/rai
HYV	668	Kgs/rai
Number of Benefiting Households	624	
Incremental Employment Created	160,992	man-years
Benefit Cost Ratio to the Farmer	1.62	
Net Present Value of Net Incremental Income to the Farmer	56,400	Baht
Economic Internal Rate of Return	17.42	Percent
Sensitivity: Case 1	9.05	"
Case 2	14.51	"
Case 3	14.80	"

Summary of Economic Analysis

Huai Chorakhe Mak

Impact of Rehabilitation

Wet Season Irrigable Area	7,000	Rai
Dry Season Irrigable Area	1,000	Rai
Paddy - Target Yield: LDV	395	Kgs/rai
HYV	495	Kgs/rai
Number of Benefiting Households	486	
Incremental Employment Created	11,664	man-years
Benefit Cost Ratio to the Farmer	1.89	
Net Present Value of Net Incremental Income to the Farmer	20,981	Baht
Economic Internal Rate of Return	10.38	Percent
Sensitivity: Case 1	7.90	"
Case 2	6.55	"
Case 3	10.17	"

Special Comments

In this sub-project dry season cropping is only possible if the current cultivation schedule for LDVs is shifted forward by 3 - 4 weeks. Rainfall data indicates that farmer could start land preparation at the beginning of May rather than June as currently happens. The present practice almost certainly reflects the unreliability of rainfall and water require at this time. With the provision of wet season supplemental irrigation this will no longer be a problem.

The low EIRR in the case of Huai Chorakhe Mak is due to a number of factors. Firstly, in an effort to maximize the potential wet season irrigable and dry season irrigable area, it is proposed that the existing area under paddy in the dry season be replaced by vegetables, mung beans and groundnuts. While these provide a good return to the farmer, when, compared with paddy, their economic value is lower, thereby reducing the level of incremental benefits from dry season cropping. In addition, this tank serves the smallest potential wet season irrigable area of the seven projects and,

Summary of Economic Analysis - Huai Chorakhe Mak (Cont'd)

has only a limited dry season cropping potential. However, since assumptions regarding the target yields of the main crops are on the conservative side, the project is considered to be fully justified on the basis of our analysis. It is also worth emphasizing that there are certain to be some indirect benefits from the project, particularly as a result of improved extension, on crop production or non-irrigable land outside of the project boundaries, but operated by project beneficiaries, where paddy is the major crop. Such indirect benefits have not been included in the economic analysis because of the difficulties of quantifying them.

Summary of Economic Analysis

Phuttha Utthayan

Impact of Rehabilitation

Wet Season Irrigable Area	14,000	Rai
Dry Season Irrigable Area	0	Rai
Paddy - Target Yield: LDV	418	Kgs/rai
HYV	506	Kgs/rai
Number of Benefiting Households	560	
Incremental Employment Created	59,920	man-years
Benefit Cost Ratio to the Farmer	1.46	
Net Present Value of Net Incremental Income to the Farmer	22,394	Baht
Economic Internal Rate of Return	27.71	Percent
Sensitivity: Case 1	6.88	"
Case 2	21.82	"
Case 3	21.73	"

Summary of Economic Analysis

Huai Aeng

Impact of Rehabilitation

Wet Season Irrigable Area	19,000	Rai
Dry Season Irrigable Area	7,800	Rai
Paddy - Target Yield: LDV	425	Kgs/rai
HYV	530	Kgs/rai
Number of Benefiting Households	1,138	
Incremental Employment Created	108,110	man-years
Benefit Cost Ratio to the Farmer	1.73	
Net Present Value of Net Incremental Income to the Farmer	56,243	Baht
Economic Internal Rate of Return	27.79	Percent
Sensitivity: Case 1	21.58	"
Case 2	24.98	"
Case 3	23.82	"

Summary of Economic Analysis

Huai Khi Lek

Impact of Rehabilitation

Wet Season Irrigable Area	9,000	Rai
Dry Season Irrigable Area	9,000	Rai
Paddy - Target Yield: LDV	395	Kgs/rai
Paddy - Target Yield: HYV	490	Kgs/rai
Number of Benefiting Households	1,443	
Incremental Employment Created	590,187	man-years
Benefit Cost Ratio to the Farmer	1.66	
Net Present Value of Net Incremental Income to the Farmer	68,469	Baht
Economic Internal Rate of Return	46.85	Percent
Sensitivity: Case 1	14.29	"
Case 2	18.38	"
Case 3	18.75	"

Summary of Economic Analysis

Huai Kaeng

Impact of Rehabilitation

Wet Season Irrigable Area	15,000	Rai
Dry Season Irrigable Area	10,000	Rai
Paddy - Target Yield: LDV	363	Kgs/rai
HYV	454	Kgs/rai
Number of Benefiting Households	720	
Incremental Employment Created	256,320	man-years
Benefit Cost Ratio to the Farmer	1.54	
Net Present Value of Net Incremental Income to the Farmer	60,389	Baht
Economic Internal Rate of Return	36.02	Percent
Sensitivity: Case 1	15.92	"
Case 2	27.06	"
Case 3	29.20	"

Summary of Economic Analysis

Huai Lam Chamuak

Impact of Rehabilitation

Wet Season Irrigable Area	10,800	Rai
Dry Season Irrigable Area	0	Rai
Paddy - Target Yield: LDV	550	Kgs/rai
Paddy - Target Yield: HYV	688	Kgs/rai
Number of Benefiting Households	540	
Incremental Employment Created	22,140	man-years
Benefit Cost Ratio to the Farmer	2.63	
Net Present Value of Net Incremental Income to the Farmer	63,739	Baht
Economic Internal Rate of Return	23.55	Percent
Sensitivity: Case 1	18.34	"
Case 2	22.30	"
Case 3	20.22	"

TABLE D4-1 PROJECT ECONOMIC ANALYSIS (All 7 Tanks Combined)

(Unit = ฿1,000)

Year	INVESTMENT COST (฿1,000)						Net Incremental Project Farm Income	Project Net Income
	Rehabilitation Cost	Vehicles & Equipment	Operation & Maintenance	Personnel & T.A.	Contingency	Total		
0	1,132	1,442	-	3,590	250	6,414	-	- 6,414
1	12,438	-	418	8,062	1,866	22,784	- 1,808	- 24,592
2	35,506	-	1,414	6,290	5,326	48,566	13,460	- 35,106
3	39,730	-	2,502	6,122	6,350	54,704	29,646	- 25,058
4	38,554	-	3,480	5,242	6,172	53,448	43,745	- 9,703
5	21,906	-	3,408	386	3,286	28,986	55,913	26,927
6		-			-	3,794	64,940	61,146
7		-			-	3,794	71,543	67,749
8		546			84	4,424		67,119
9		-			-	3,794		67,749
10		-			-	3,794		67,749
11		-			-	3,794		67,749
12		-			-	3,794		67,749
13		-			-	3,794		67,749
14		-			-	3,794		67,749
15		-			-	3,794		67,749
16		546			84	4,424		67,119
17		-			-	3,794		67,749
18		-			-	3,794		67,749
19		-			-	3,794		67,749
20	- 23,319	- 205	3,408	386	-	- 19,730	71,543	91,273
								EIRR = 31.41

TABLE D 4-2 - FARM FINANCIAL ANALYSIS

Year	Huai Talat #1		H. Chorakhe Mak #2		Phuttha Utthayan #5		Huai Aeng #6		Huai Khi Lek #7		Huai Kaeng #8		H. Lam Chamuak #9	
	Incremental Farm		Incremental Farm		Incremental Farm		Incremental Farm		Incremental Farm		Incremental Farm		Incremental Farm	
	Income ฿	Cost ฿	Income ฿	Cost ฿	Income ฿	Cost ฿	Income ฿	Cost ฿	Income ฿	Cost ฿	Income ฿	Cost ฿	Income ฿	Cost ฿
0	- 1,898	- 681	- 2,144	-1,530	0	281	251	194	535	379	732	1,083	793	745
1	4,275	2,605	555	- 38	2,444	1,684	3,931	2,766	3,905	2,406	6,711	5,264	4,605	2,157
2	9,088	5,665	2,895	1,453	4,911	3,392	8,848	5,289	9,565	5,922	13,766	9,215	9,238	4,122
3	15,155	9,446	5,240	2,887	7,288	5,014	14,802	8,575	15,985	9,664	21,375	13,927	11,735	4,882
4	20,405	12,836	6,784	3,761	9,595	6,586	19,527	10,963	22,148	13,560	25,427	16,309	13,818	5,093
5	24,702	15,343	7,648	4,187	11,348	7,803	21,910	12,613	27,730	16,806	27,812	17,688	15,812	5,853
6	26,884	16,458	8,370	4,553	12,630	8,577	23,192	13,312	31,535	18,795	28,654	18,290	17,209	6,214
7														
8														
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12														
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14														
15														
16														
17														
18														
19														
20														
Present Value	148,046	91,646	44,520	23,539	71,323	48,929	133,417	77,174	171,438	102,969	172,621	112,232	103,099	39,360
B/C Ratio	1.62		1.89		1.46		1.73		1.66		1.54		2.63	
Net P.V.income per farm (฿1,000)	56.40		20.98		22.39		56.24		68.47		60.39		63.74	
Net P.V.income per project (฿1,000)	35,194		10,197		12,541		64,004		36,152		43,480		34,419	

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HUAI TALAT

AVERAGE FARM BUDGET WITH AND WITHOUT PROJECT

		Without Project	With Project
Inside Project Area[a/]			
Land Area[b/]	(rai)	22.64	22.64
Cropped Area			
Wet Season LDV Rice	(rai)	22.23	8.94
RDV Rice	(rai)	-	13.40
Kenaf	(rai)	0.04	0.04
Vegetables	(rai)	0.03	0.10
Other [c/]	(rai)	-	-
Dry Season LDV Rice	(rai)	0.97	-
Mung Beans	(rai)	-	4.71
Groundnuts	(rai)	-	3.85
Vegetables/fruits	(rai)	-	0.25
Other [c/]	(rai)	-	-
Upland Crops (Manioc/Trees)	(rai)	0.15	0.15
Total	(rai)	23.42	31.44
Cropping Intensity		1.04	1.39
Crop Production [d/]			
Wet Season LDV Rice	(Kg)	7,547	4,783
RDV Rice	(Kg)	0	8,951
Kenaf	(Kg)	8	10
Dry Season LDV Rice	(Kg)	281	-
Mung Beans	(Kg)	-	895
Groundnuts	(Kg)	-	1,155
Total Labour Requirement	(man-days)	300	558
Gross Value of Production	(฿)	19,703	46,587
Production Costs, excl. Labour	(฿)	1,933	11,969
Hired Labour Costs	(฿)	1,349	3,840
Net Crop Income, Inside Project Area	(฿)	16,421	30,778
Net Crop Income incl. HH. Labour Cost	(฿)	11,141	22,025
Outside Project Area			
Land Area	(rai)	17.01	17.01
Cropped Area	(rai)	17.01	17.01
Net Crop Income, Outside Project Area	(฿)	9,288	9,288
Net Crop Income, incl. HH. Labour Costs	(฿)	5,364	5,364
Total Net Crop Income	(฿)	25,709	40,066
Total Net Crop Income (incl. HH. Labour)	(฿)	16,505	27,389
Net Farm Income From Livestock/Fisheries[e/]	(฿)	5,335	5,335
Other Farm Costs[f/]		1,784	2,242
Total Net Farm Income	(฿)	29,260	43,159
Cost Recovery[g/]		-	3,136
O & M Costs		-	949
Capital Costs		-	2,188
Net Farm Income	(฿)	29,260	40,023

HUAI CHORAKHAEMAK

AVERAGE FARM BUDGET WITH AND WITHOUT PROJECT

		Without Project	With Project
Inside Project Area a/			
Land Area b/	(rai)	14.34	14.34
Cropped Area			
Wet Season LDV Rice	(rai)	13.75	5.72
RDV Rice	(rai)	-	8.58
Kenaf	(rai)	-	-
Vegetables	(rai)	0.04	0.10
Other c/	(rai)	-	-
Dry Season LDV Rice	(rai)	2.92	0
Mung Beans	(rai)	0.03	1.06
Groundnuts	(rai)	0	0.70
Vegetables/Fruits	(rai)	0.01	0.30
Other c/	(rai)	-	-
Upland Crops (Manioc/Trees)	(rai)	-	-
Total	(rai)	16.75	16.46
Cropping Intensity		1.17	1.15
Crop Production d/			
Wet Season LDV Rice	(Kg)	3,431	2,259
RDV Rice	(Kg)	-	4,247
Kenaf	(Kg)	-	-
Dry Season LDV Rice	(Kg)	844	-
Mung Beans	(Kg)	4	201
Groundnuts	(Kg)	0	210
Total Labour Requirement	(man-days)	281	634
Gross Value of Production	(฿)	10,746	19,244
Production Costs, excl. Labour	(฿)	1,775	5,703
Hired Labour Costs	(฿)	902	1,122
Net Crop Income, Inside Project Area	(฿)	8,069	12,419
Net Crop Income incl. HH. Labour Cost	(฿)	2,696	6,767
Outside Project Area			
Land Area	(rai)	5.23	5.23
Cropped Area	(rai)	5.20	5.20
Net Crop Income, Outside Project Area	(฿)	2,100	2,100
Net Crop Income, incl. HH. Labour Costs	(฿)	555	555
Total Net Crop Income	(฿)	10,169	14,519
Total Net Crop Income (incl. HH. Labour)	(฿)	3,251	7,322
Net Farm Income From Livestock/Fisheries e/	(฿)	10,665	10,665
Other Farm Costs f/		1,655	1,830
Total Net Farm Income	(฿)	19,179	23,354
Cost Recovery g/		-	1,998
O & M Costs		-	584
Capital Costs		-	1,414
Net Farm Income	(฿)	19,179	21,356

PUTTHA-UTTAYAN

AVERAGE FARM BUDGET WITH AND WITHOUT PROJECT

		Without Project	With Project
Inside Project Area[a/]			
Land Area[b/]	(rai)	24.99	24.99
Cropped Area			
Wet Season LDV Rice	(rai)	24.41	9.96
RDV Rice	(rai)	-	14.93
Kenaf	(rai)	-	-
Vegetables	(rai)	0.05	0.10
Other [d/]	(rai)	-	-
Dry Season LDV Rice	(rai)	0.16	-
Mung Beans	(rai)	-	-
Groundnuts	(rai)	-	-
Vegetables/Fruits	(rai)	0.51	0.25
Other [d/]	(rai)	0.65	-
Upland Crops (Manioc/Trees)	(rai)	-	-
Total	(rai)	25.78	25.24
Cropping Intensity		1.03	1.01
Crop Production [d/]			
Wet Season LDV Rice	(Kg)	6,276	4,163
RDV Rice	(Kg)	-	7,553
Vegetables/fruits	a/	15	35
Dry Season LDV Rice	(Kg)	40	-
Mung Beans	(Kg)	-	-
Groundnuts	(Kg)	-	-
Other	b/	1,160	-
Total Labour Requirement	(man-days)	356.25	462.5
Gross Value of Production	(฿)	17,070	29,700
Production Costs, excl. Labour	(฿)	2,455	8,374
Hired Labour Costs	(฿)	902	2,904
Net Crop Income, Inside Project Area	(฿)	13,713	18,422
Net Crop Income incl. HH. Labour Cost	(฿)	6,722	11,137
Outside Project Area			
Land Area	(rai)	1.17	1.17
Cropped Area	(rai)	1.17	1.17
Net Crop Income, Outside Project Area	(฿)	439	439
Net Crop Income, Incl. HH. Labour Costs	(฿)	132	132
Total Net Crop Income	(฿)	14,152	18,861
Total Net Crop Income (incl. HH. Labour)	(฿)	6,854	11,269
Net Farm Income From Livestock/Fisheries[e/]	(฿)	4,129	4,129
Other Farm Costs[f/]		2,710	3,073
Total Net Farm Income (excl. HH. Labour)	(฿)	15,571	19,917
Cost Recovery[g/]		-	3,124
O & M Costs		-	717
Capital Costs		-	2,406
Net Farm Income	(฿)	15,571	16,793

HUAI ANG

AVERAGE FARM BUDGET WITH AND WITHOUT PROJECT

		Without Project	With Project
Inside Project Area[a]			
Land Area[b]	(rai)	18.14	18.14
Cropped Area			
Wet Season LDV Rice	(rai)	16.50	6.60
RDV Rice	(rai)	-	9.90
Kenaf	(rai)	0.44	0.44
Vegetables	(rai)	0.07	0.10
Other[c]	(rai)	-	-
Dry Season LDV Rice	(rai)	0.53	-
Mung Beans	(rai)	-	3.20
Groundnuts	(rai)	0.52	2.15
Vegetables/Fruits	(rai)	1.41	1.00
Other[c]	(rai)	0.79	0.50
Upland Crops (Manioc/Trees)	(rai)	0.62	0.62
Total	(rai)	20.88	24.51
Cropping Intensity		1.15	1.35
Crop Production[d]			
Wet Season LDV Rice	(Kg)	4,092	2,805
RDV Rice	(Kg)	-	5,247
Kenaf	(Kg)	51	61
Dry Season LDV Rice	(Kg)	107	-
Mung Beans	(Kg)	-	608
Groundnuts	(Kg)	44	645
Other	b/	990	627
Total Labour Requirement	(man-days)	376	471
Gross Value of Production	(฿)	13,734	30,229
Production Costs, excl. Labour	(฿)	1,965	8,028
Hired Labour Costs	(฿)	616	1,417
Net Crop Income, Inside Project Area	(฿)	11,153	20,784
Net Crop Income incl. HH. Labour Cost	(฿)	3,570	11,857
Outside Project Area			
Land Area	(rai)	9.33	9.33
Cropped Area	(rai)	9.33	9.33
Net Crop Income, Outside Project Area	(฿)	2518	2518
Net Crop Income, incl. HH. Labour Costs	(฿)	-83	-83
Total Net Crop Income	(฿)	13,671	23,302
Total Net Crop Income (incl. HH. Labour)	(฿)	3,487	11,774
Net Farm Income From Livestock/Fisheries[e]	(฿)	5,840	5,840
Other Farm Costs[f]		1,808	2,086
Total Net Farm Income	(฿)	17,703	27,056
Cost Recovery[g]		-	1,909
O & M Costs		-	293
Capital Costs		-	1,115
Net Farm Income	(฿)	17,703	25,147

HUAI KHILEK

AVERAGE FARM BUDGET WITH AND WITHOUT PROJECT

		Without Project	With Project
Inside Project Area a/			
Land Area b/	(rai)	20.39	20.39
Cropped Area			
Wet Season LDV Rice	(rai)	12.03	6.63
RDV Rice	(rai)	0	10.02
Kenaf	(rai)	0.52	0.52
Vegetables	(rai)	0.35	0.35
Other g/	(rai)	0.71	0.61
Dry Season LDV Rice	(rai)	0.17	0
Mung Beans	(rai)	0	9.3
Groundnuts	(rai)	0.50	5.92
Vegetables/fruits	(rai)	0.96	1.70
Other g/	(rai)	0.31	0.31
Upland Crops (Manioc/Trees)	(rai)	3.20	2.22
Total	(rai)	18.75	37.58
Cropping Intensity		0.92	1.84
Crop Production d/			
Wet Season LDV Rice	(Kg)	2,891	2,607
RDV Rice	(Kg)	0	4,910
Kenaf	(Kg)	59	59
Dry Season LDV Rice	(Kg)	49	0
Mung Beans	(Kg)	0	1,763
Groundnuts	(Kg)	200	1,776
Other	b/	25	25
Total Labour Requirement	(man-days)	230	639
Gross Value of Production	(฿)	13,457	44,417
Production Costs, excl. Labour	(฿)	2,721	11,394
Hired Labour Costs	(฿)	630	4,146
Net Crop Income, Inside Project Area	(฿)	10,106	28,877
Net Crop Income incl. HH. Labour Cost	(฿)	5,606	18,169
Outside Project Area			
Land Area	(rai)	1.27	1.27
Cropped Area	(rai)	1.10	1.10
Net Crop Income, Outside Project Area	(฿)	640	640
Net Crop Income, incl. HH. Labour Costs	(฿)	302	302
Total Net Crop Income	(฿)	10,746	29,517
Total Net Crop Income (incl. HH. Labour)	(฿)	5,908	18,169
Net Farm Income From Livestock/Fisheries e/	(฿)	5,662	5,662
Other Farm Costs f/		8,371	8,769
Total Net Farm Income	(฿)	8,037	26,410
Cost Recovery g/		-	6,076
O & M Costs		-	1,076
Capital Costs		-	4,999
Net Farm Income	(฿)	8,037	20,334

HUAI KAENG

AVERAGE FARM BUDGET WITH AND WITHOUT PROJECT

		Without Project	With Project
Inside Project Area[a]			
Land Area[b]	(rai)	22.78	22.78
Cropped Area			
Wet Season LDV Rice	(rai)	17.77	8.18
RDV Rice	(rai)	0	12.27
Kenaf	(rai)	0.14	0.14
Vegetables	(rai)	0.01	0.10
Other [c]	(rai)	0.05	0.05
Dry Season LDV Rice	(rai)	-	-
Mung Beans	(rai)	0	7.32
Groundnuts	(rai)	1.49	5.98
Vegetables/fruits	(rai)	0.19	0.35
Other [c]	(rai)	-	-
Upland Crops (Manioc/Trees)	(rai)	1.41	1.41
Total	(rai)	21.06	35.80
Cropping Intensity		0.92	1.57
Crop Production [d]			
Wet Season LDV Rice	(Kg)	4,223	2,969
RDV Rice	(Kg)	0	5,571
Kenaf	(Kg)	34	38
Dry Season LDV Rice	(Kg)	-	-
Mung Beans	(Kg)	0	1,391
Groundnuts	(Kg)	110	1,794
Total Labour Requirement	(man-days)	247	603
Gross Value of Production	(฿)	12,335	41,010
Production Costs, excl. Labour	(฿)	1,048	10,675
Hired Labour Costs	(฿)	364	3,404
Net Crop Income, Inside Project Area	(฿)	10.943	26,931
Net Crop Income incl. HH. Labour Cost	(฿)	5,929	16,765
Outside Project Area			
Land Area	(rai)	2.11	2.11
Cropped Area	(rai)	1.45	1.45
Net Crop Income, Outside Project Area	(฿)	1,827	1,827
Net Crop Income, incl. HH. Labour Costs	(฿)	1,463	1,463
Total Net Crop Income	(฿)	12,770	28,758
Total Net Crop Income (incl. HH. Labour)	(฿)	7,392	18,228
Net Farm Income From Livestock/Fisheries[e]	(฿)	7,910	7,910
Other Farm Costs[f]		9,948	10,421
Total Net Farm Income	(฿)	10,732	26,247
Cost Recovery[g]		-	1,370
O & M Costs		-	1,182
Capital Costs		-	188
Net Farm Income	(฿)	10,732	24,877

HUAI LAM CHAMAUK

Average Farm Budget with and without Project

		Without Project	With Project
Inside Project Area[a]			
Land Area[b]	(rai)	26.99	26.99
Cropped Area			
Wet Season LDV Rice	(rai)	18.28	7.98
RDV Rice	(rai)	-	11.96
Kenaf	(rai)	0.31	0.31
Vegetables	(rai)	0.02	0.10
Other c)	(rai)	-	-
Dry Season LDV Rice	(rai)		
Mung Beans	(rai)	1.14	-
Groundnuts	(rai)	2.65	-
Vegetables/fruits	(rai)	0.19	0.25
Other c)	(rai)	0.09	0.09
Upland Crops (Manioc/Trees)	(rai)	6.80	6.64
Total	(rai)	25.41	27.33
Cropping Intensity		0.94	1.01
Crop Production[d]			
Wet Season LDV Rice	(Kg)	6,727	4,389
RDV Rice	(Kg)	-	8,228
Kenaf	(Kg)	11	14
Dry Season LDV Rice	(Kg)	-	-
Mung Beans	(Kg)	29	-
Groundnuts	(Kg)	107	-
Total Labour Requirement	(man-days)	424	465
Gross Value of Production	(฿)	26,048	43,257
Production Costs, excl. Labour	(฿)	2,611	7,745
Hired Labour Costs	(฿)	2,090	3,285
Net Crop Income, Inside Project Area	(฿)	21,347	32,227
Net Crop Income incl. HH. Labour Cost	(฿)	13,910	25,177
Outside Project Area			
Land Area	(rai)	20.57	20.57
Cropped Area	(rai)	15.11	15.11
Net Crop Income, Outside Project Area	(฿)	6,902	6,902
Net Crop Income, incl. HH. Labour Costs	(฿)	3,732	3,732
Total Net Crop Income	(฿)	28,249	39,129
Total Net Crop Income (incl. HH. Labour)	(฿)		
Net Farm Income From Livestock/Fisheries[e]	(฿)	6,284	6,284
Other Farm Costs[f]		4,911	5,183
Total Net Farm Income	(฿)	29,622	40,230
Cost Recovery[g]		—	810
O & M Costs		—	759
Capital Costs		—	51
Net Farm Income	(฿)	29,622	39,420

Annex E

1. Equipment Costs
2. Vehicle Costs
3. Service Center Buildings
4. Consultants
5. Total Costs per Site
6. Software Components

Equipment Costs ($US)

9 Surveying sets @ 2,000 each	$ 18,000
9 Soil test sets @ 750 each	6,750
2 Hand-held power augers @ 1,000 each	2,000
7 Bull horns @ 200 each	1,400
14 Cameras @ 100 each	1,400
15 Hand levels @ 100 each	1,500
3 Drafting sets @ 250 each	750
3 Calculators @ 100 each	300
8 25 m. tape measures @ 75 each	600
7 Overhead projector @ 400	2,800
7 Slide projectors @ 300	2,100
7 Loud speaker sets @ 500	3,500
14 Typewriters @ 500	7,000
	$ 48,100
Vehicles	86,600
	$134,700
	÷ 7
	$ 19,243/tank

LC (Local Cost)

Equipment	$48,100
Motorcycles	26,600
	$74,700

Vehicle Costs ($US)

Tank	Agency	Year 1	2	3	4	5	6	Total
1	PM O&M	1,144	3,432	3,432	3,432	3,432	3,432	
	EA O&M (2)		474	1,900	1,900	1,900	1,900	
	SS O&M (2)		474	1,900	1,900	1,900	1,900	
	TS O&M (1)	1,144						
	Soil Survey O&M (1)	1,144						
	Construct Supv. O&M (2)		948	948				
2	SS O&M		474	1,900	1,900	1,900	1,900	
	EA O&M		474	1,990	1,900	1,900	1,900	
	TS O&M		1,144					
	SS O&M		1,144					
	CS O&M			948	948			
3	SS O&M		474	1,900	1,900	1,900	1,900	
	EA O&M		474	1,900	1,900	1,900	1,900	
	TS O&M		1,144					
	SS O&M		1,144					
	CS O&M			948	948			
4	SS O&M			474	1,900	1,900	1,900	
	EA O&M			474	1,900	1,900	1,900	
	TS O&M			1,144				
	SS O&M			1,144				
	CS O&M				948	948		
5	SS O&M			474	1,900	1,900	1,900	
	EA O&M			474	1,900	1,900	1,900	
	TS O&M			1,144				
	SS O&M			1,144				
	CS O&M				948	948		
6	SS O&M				474	1,900	1,900	
	EA O&M				474	1,900	1,900	
	TS O&M				1,144			
	SS O&M				1,144			
	CS O&M					948	948	
7	SS O&M				474	1,900	1,900	
	EA O&M				474	1,900	1,900	
	TS O&M				1,144			
	SS O&M				1,144			
	CS O&M					948	948	
	TOTAL							131,806

	Proj. Mgr. - 1 jeep @ 12,000		12,000
	SMS's - 16 motorcycles @ 700		11,200
Total Vehicles:	Extension Agents - 14 motorcycles @ 700	=	9,800
	Topo Survey - 2 jeeps @ 12,000		24,000
	Soil Survey - 2 jeeps @ 12,000		24,000
	Construction Superv. - 8 motorcycles @ 700	=	5,600
			$86,600

SERVICE CENTER BUILDINGS AND EQUIPMENT - DESCRIPTION AND COSTS

TANK 1 (Consultant Head Quarters):

1. Building: A single story, concrete block and wooden building with corrugated asbestos sheet roof, concrete slab floor on ground; 8m x 14m, consisting of three individual offices, one group office, and a meeting room; electrical wiring and plumbing; separate latrine. (See drawing) Cost ฿153,500

2. Equipment/Furnishings:

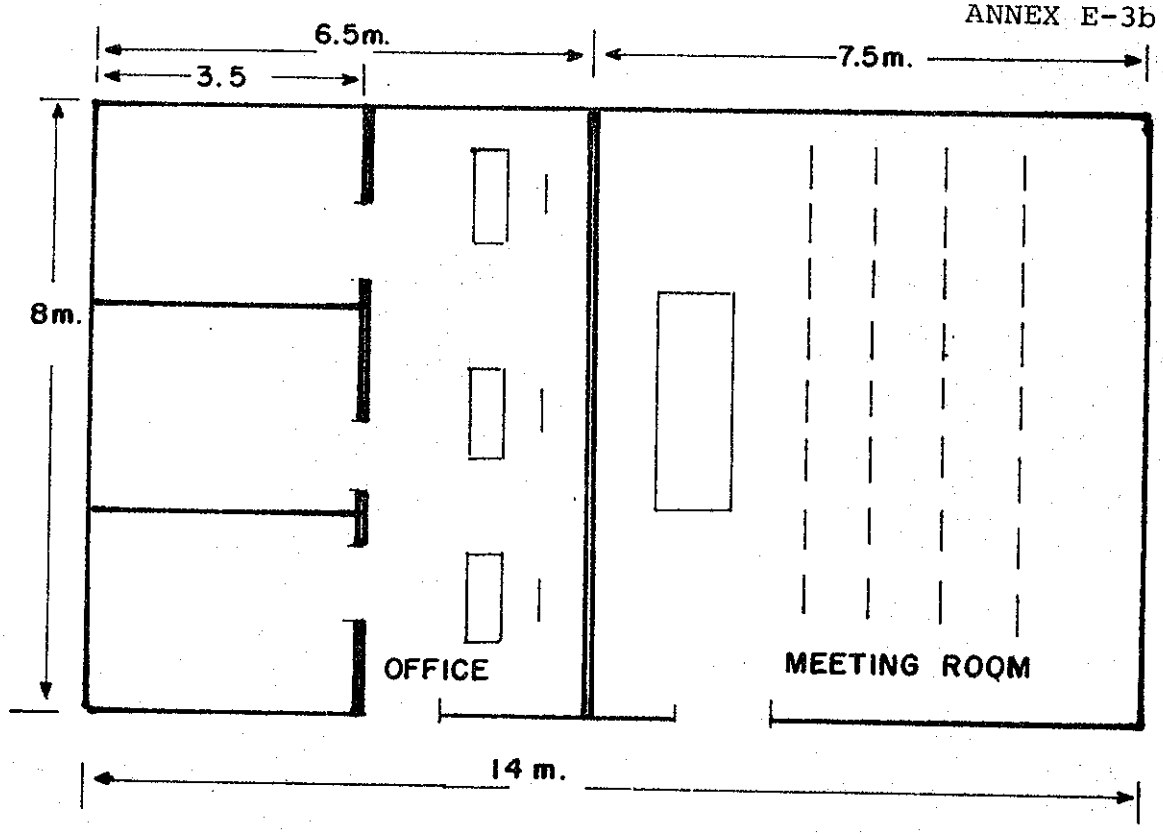
	Amount	Unit Cost(฿)	Cost (฿)
Special Desk & Chair	8	2,500	20,000
Regular Desk & Chair	4	1,500	6,000
Typing Desk & Chair	2	1,000	2,000
Storage Cabinet, steel	2	1,000	2,000
4 Drawer File, steel	4	1,000	4,000
16" Electric Fan	8	1,250	10,000
Meeting Room Chair	50	60	3,000
Meeting Room Table	1	7,000	7,000
			54,000
		Total Cost	฿207,000

TANKS 2 through 7:

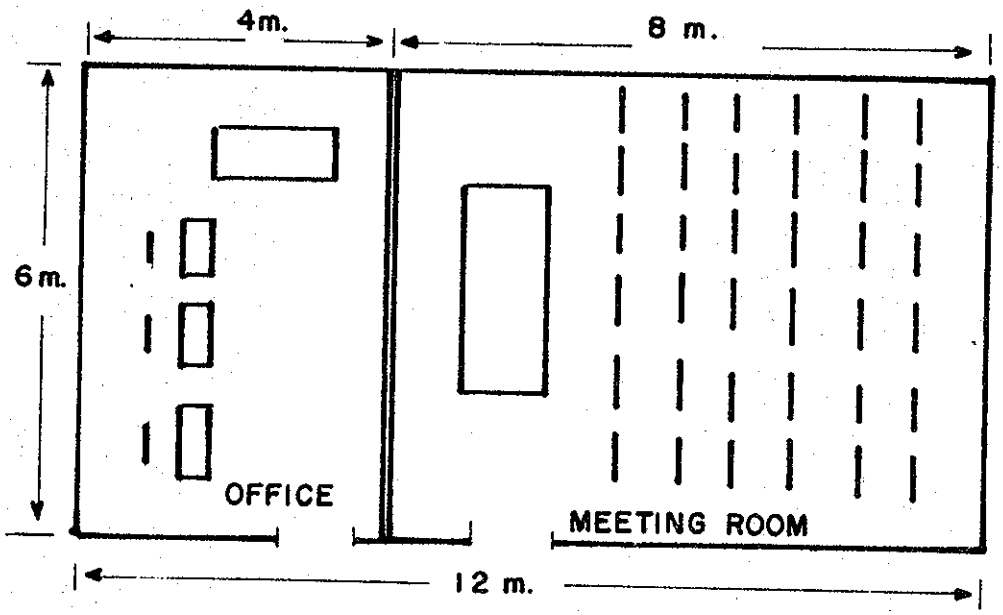
1. Building: a single story, concrete block and wooden building with corrugated asbestos sheet roof, concrete slab floor on ground; 6m x 12m consisting of one group office and a meeting room; electrical wiring and plumbing; separate latrine. (See drawing) Cost ฿113,500

2. Equipment/Furnishings:

	Amount	Unit Cost(฿)	Cost (฿)
Regular Desk & Chair	4	1,500	6,000
Storage Cabinet, steel	1	1,000	1,000
4 Drawer File, steel	2	1,000	2,000
16" Electric Fan	3	1,250	3,750
Meeting Room Chair	50	60	3,000
Meeting Room Table	1	7,000	7,000
			22,750
		Total Cost	฿136,250



SERVICE CENTER — CONSULTANT HEADQUARTERS



SERVICE CENTER OFFICE

Cost Breakdowns for Consultants

Table A. Foreign Consultants

	6 mos	9 mos	1 yr
AID			
Salary ($150 day)	$19,500	$29,250	$39,000
Post Diff. (10%)	1,950	2,925	3,900
			5,000
Travel Trans*	11,800	11,800	11,800
Medical/Ins.	300	300	300
Workmen's Comp (12%)	2,340	3,510	4,680
Materials	150	200	250
Total	$36,000	$47,985	$64,930
RTG			
Local Travel			
- per diem (฿600x10d/mo)	฿ 36,000	฿ 54,000	฿ 96,000
- transport	12,000	18,000	24,000
Quarters Allowance			
- temporary (฿600 x 15 days)(short term ฿1,460/day)	262,800	384,300	384,300
Regular Quarter Allowance $9460/yr = ฿15,800/mo			
- regular (฿4,000/mo.)	-	94,800	142,200
Secretary (฿3,000/mo.)	18,000	27,000	36,000
Transportation to Office	6,000	9,000	12,000
Misc.	5,000	5,000	5,000
Total	฿339,800	฿592,100	฿699,600
	$ 16,990	$ 29,605	$ 34,980
Total Cost	$ 52,990	$ 77,590	$ 99,910

*includes 3 dependents when period over 3 months

Employee, wife & 2 children (1 over 12 & 1 under) = 3.5 persons.
Education allowance $2,250 + $2,650 = $4,900 or ฿98,000 + Lab. Fee ฿300 + Transportation ฿8,800 = ฿102,700 for 2 children/year.

Table B. Thai Consultants

	3 mos	6 mos	9 mos	1 yr
AID				
Salary	45,000	90,000	135,000	180,000
Materials	2,000	3,000	4,000	5,000
Total	47,000	93,000	139,000	185,000
RTG				
Quarters Allowance	13,000	25,000	37,000	49,000
Local Travel	8,500	17,000	25,500	34,000
Secretary	9,000	18,000	27,000	36,000
Transportation to Office	3,000	6,000	9,000	12,000
Recruitment, Insurance, Misc.	800	9,000	10,000	11,000
Total	41,500	75,000	108,500	142,000
Total Cost Baht	88,500	168,000	247,500	327,000
US$	4,425	8,400	12,375	16,350

Tables a and b provide cost estimates for the first year of the project. Years 2-5 should be inflated by a minimum of 10% annually.

Consultant Cost to be Paid by DTEC ($US)

	Year					
	1	2	3	4	5	Total
Man Yrs	2.7	3.5	6.3	5.1	2.7	25.3
X Housing (7,000/yr), In-country travel (1,000/yr) and in-country per diem (5,000/yr) = total 13,000/yr. —	35,100	110,500	81,900	66,300	35,100	328,900
X Inflation 10%/yr	1.1	1.21	1.33	1.46	1.61	
Subtotal to subtract from AID consultant costs.	38,610	133,700	108,930	96,800	56,500	434,540
339/mo each {3 driver's salaries, O&M for 3 pickups}	3,050	12,200	12,200	12,200	12,200	51,850
w/infl	1,100	4,840	5,320	5,840	6,440	23,540
167/mo each 2 secretary's salaries	1,000	4,000	4,000	4,000	2,000	15,000
Subtotal	4,050	16,200	16,200	16,200	14,200	
X Inflation 10%/yr.	1.1	1.21	1.33	1.46	1.61	
Subtotal	4,455	19,600	21,550	23,650	22,860	use 90,000
Total						526,650

	U.S.	Thai	Total
Man months	127	177	304
Man Years		14.8	25.3
%			
Salaries	1,270,000	368,691	

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ANNEX E-5

PROJECT COSTS (1,000 $ US) - All Sites

Item	Huai Talat		Huai Chorakhe Mak		Phuttha Utthayan		Huai Aeng		Huai Khi Lek		Huai Kaeng		Lam Chamuak		TOTAL	
	RTG	AID	RTG	AID	RTG	AID	RTG	AID	RTG	AID	RTG	AID	RTG	AID	RTG	AID
Embankments	265.3		147.9		50.9		0		0		0		0		464.1	
Main Canals																
Lining	481.1		147.5		265.9		218.8		185.0		79.4		209.7		1,587.4	
Structures/Drainage	12.9		14.8		15.3		9.2		10.1		18.3		7.8		88.4	
Lateral Canals																
Lining	48.0		0		22.3		159.8		112.6		118.3		13.4		474.4	
Structures	5.9		0		0		6.6		7.6		10.8		0		30.9	
Access Roads	206.4		116.5		95.6		179.6		124.7		233.1		126.6		1,082.5	
Sub-lateral canals		27.9		15.8		21.9		36.7		24.4		49.6		9.8		186.1
Land Preparation		347.2		173.6		415.3		471.2		544.2		695.3		380.9		3,027.7
Service Centers		8.5		8.5		8.5		13.5		8.5		8.5		8.5		64.5
Maintenance	56.4		34.8		59.2		84.9		101.0		161.6		64.7		562.6	
RTG Staff Salaries	22.9		22.9		24.9		28.6		26.9		26.9		24.9		178.0	
RTG Staff Per Diem		7.6		7.6		7.7		9.7		7.8		7.8		7.7		55.[illegible]
Vehicles/Equipment		19.2		19.2		19.2		19.2		19.2		19.2		19.2		134.4
Vehicle O & M		12.8		12.8		16.6		39.5		20.4		20.4		16.6		139.1
Subtotal	1,098.9	423.2	484.4	237.5	534.1	489.2	687.5	589.8	567.9	624.5	648.4	800.0	447.1	442.7	4,468.3	3,607.7
Contingency(15%)	164.8	63.5	72.6	35.6	80.1	73.3	103.1	88.5	85.2	93.7	97.3	120.1	67.0	66.4	670.1	541.1
Inflation(10%yr)	755.9	273.8	331.1	145.7	288.9	249.1	204.4	160.6	239.8	239.6	273.8	309.0	241.8	224.3	2,335.7	1,602.1
TOTAL	2,019.6	760.5	888.1	418.8	903.1	811.6	995.0	838.9	892.9	957.8	1,019.5	1,229.9	755.9	733.4	7,474.1	5,750.0

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Software Components

	Quantity	Cost	
		DTEC	AID
Technical Assistance	Approximately 27 man-years of technical assistance.	$540,000	$2,220,000
Market Support	Farmer trips transport of goods, etc.		50,000
Demonstrations	Seeds fertilizers Pesticide for demonstration plots (3 per year per site)		10,000
Crop Insurance	Insurance of up to 50% of market value of farmers crops on demonstration basis.		200,000
Evaluation	Two evaluations		100,000
Farmer observation travel to successful systems.	Two trips per site		40,000
Research and workshop	Operational research and 2 workshops per site.	10,000	90,000
Contingency			50,000
Total		$550,000	$2,760,000

Annex F

Thailand - Small Scale Irrigation Project Certification Pursuant to Section 611(e) of the Foreign Assistance Act of 1961, as Amended.

I, Donald D. Cohen, principal officer of the Agency for International Development in Thailand, having taken into account among other things the maintenance and utilization of projects in Thailand previously financed or assisted by the U.S. and the commitment of the Royal Thai Government to carry out an effective Small Scale Irrigation program, do hereby certify that in my judgement Thailand has the financial and human resources capability to implement, maintain, and utilize effectively the subject Small Scale Irrigation Project.

Date: _____

_____
Donald D. Cohen
Director, USAID/Thailand

ANNEX G

PROJECT CHECKLIST

A. General Criteria for Project

1. FY 79 App. Act Unnumbered; FAA Sec. 653 (b); Sec. 634A. (a) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure)?	(a) The project was not included in in AID's FY 1980 Congressional Presentation. A notification of the project will accordingly be forwarded to Congress and the required waiting period observed prior to obligating funds for the project; (b) Proposed loan assistance is within OYB, but additional funding will be sought for the grant component.
2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?	Agreed plans and cost estimates are incorporated into the Project Paper.
3. FAA Sec. 611(a)(2). If fur ther legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?	No further legislation is required.
4. FAA Sec. 611(b); FY 79 App. Act Sec. 101. If for water or water-related land resource construction, has project met the standards and criteria as per the Principles and Standards for Planning Water and Related Land Resources dated October 25, 1973?	All appropriate standards and criteria have been met.

5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?	Director's certified statement is incorporated in the Project Paper.
6. FAA Sec. 209. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	No.
7. FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.	No significant effect expected.
8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).	The Project is not designed to have any significant effect on any of these items.

9. FAA Sec. 612(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is con tributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.	The Royal Thai Government contribution to this Project will exceed 25%. There are no US owned local currencies available for this Project.
10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?	No
11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?	Yes
12. FY 79 App. Act Sec. 608. If assistance is for the pro duction of any commodity for export, is the commodity like ly to be in surplus on world markets at the time the result ing productive capacity becomes operative, and is such assis tance likely to cause substan tial injury to U.S. producers of the same, similar, or com peting commodity?	N/A

B. Funding Criteria for Project

1. Development Assistance Project Criteria

a. FAA Sec. 102(b); 111; 113; 281a. Extent to which activity will (a) effectively involve the poor in

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development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?

Project is designed to increase income of poor rural people in Northeast Thailand through improved use of available water resources. Appropriate technology will be used to established benefits. Benefits from the improved irrigation systems will be forthcoming on a sustained basis once established.

b. FAA Sec. 103, 103A, 104, 105, 106, 107. Is assistance being made available: (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.)

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(1) (103) for agriculture, rural development or nutrition; if so, extent to which activity is specifically designed to increase productivity and income of rural poor; (103A) if for agricultural research, is full account taken of needs of small farmers;	The Project purpose is to increase the income of the small farmers in Northeast Thailand.
(2) (104) for population planning under sec. 104(b) or health under sec. 104(c); if so, extent to which activity emphasizes low-cost, integrated delivery systems for health, nutrition and family planning for the poorest people, with particular attention to the needs of mothers and young children, using paramedical and auxiliary medical personnel, clinics and health posts, commercial distribution systems and other modes of community research.	
(3) (105) for education, public administration, or human resources development; if so, extent to which activity strengthens nonformal education, makes formal education more relevant, especially for rural families and urban poor, or strengthens management capability of institutions enabling the poor to participate in development;	

(4) (106) for technical assistance, energy, research, reconstruction, and selected development problems; if so, extent activity is:

(i) technical cooperation and development, especially with U.S. private and voluntary, or regional and international development, organizations;

(ii) to help alleviate energy problem;

(iii) research into, and evaluation of, economic development processes and techniques;

(iv) reconstruction after natural or manmade disaster;

(v) for special development problem, and to enable proper utilization of earlier U.S. infrastructure, etc., assistance;

(vi) for programs of urban development, especially small labor-intensive enterprises, marketing systems, and financial or other institutions to help urban poor participate in economic and social development.

c.	(107) Is appropriate effort placed on use of appropriate technology?	N/A
d.	FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the as sistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least-developed" country)?	Yes.
e.	FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?	No grant fund will be used for the capital project portion of this Project.
f.	FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental and political processes essential to self-government.	Project will satisfy peoples' felt needs for better access to water for irrigation, Local Water User Associations will play an active role in management of the Project.
g.	FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase or productive capacities and self-sustaining economic Growth?	Yes, these are major objectives.

2. Development Assistance Project Criteria (Loans only)

a. FAA Sec. 122(b). Information and conclusion on capacity of the country to repay the loan, including reasonableness of repayment prospects.	There is a reasonable expectation that the loan portion of the Project will be promptly repaid.
b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete in the U.S. with U.S. enterprise, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?	N/A

3. Project Criteria Solely for Economic Support Fund

a. FAA Sec. 531(a). Will this assistance support promote economic or political stability? To the extent possible, does it reflect the policy directions of section 102?	N/A
b. FAA Sec. 533. Will assistance under this Chapter be used for military, or paramilitary activities?	N/A

PROJECT AUTHORIZATION

Name of Country: Thailand

Name of Project: Northeast Small Scale Irrigation

Number of Project: 493-0312

1. Pursuant to Section 103 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Northeast Small Scale Irrigation Project for Thailand involving planned obligations of not to exceed $5,800,000 in loan funds and $2,800,000 in grant funds over a six year period from date of authorization, subject to the availability of funds in accordance with the A.I.D. OYB/allotment process, to help in financing foreign exchange and local currency costs for the project.

2. The project will establish a replicable approach and institutional capabilities for increasing agricultural incomes for small farmers within command areas of existing tank irrigation systems in Northeast Thailand.

3. The Project Agreement which may be negotiated and executed by the officer to whom such authority is delegated in accordance with A.I.D. regulations and Delegations of Authority shall be subject to the following essential terms and covenants and major conditions, together with such other terms and conditions as A.I.D. may deem appropriate.

4. a. Interest Rate and Terms of Repayment

The Cooperating Country shall repay the Loan to A.I.D. in U.S. dollars within forty (40) years from the date of first disbursement of the Loan, including a grace period of not to exceed ten (10) years. The Cooperating Country shall pay to A.I.D. in U.S. Dollars interest from the Date of first disbursement of the Loan at the rate of (a) two percent (2%) per annum during the first ten (10) years, and (b) three percent (3%) per annum thereafter, on the outstanding disbursed balance of the Loan and on any due and unpaid interest accrued thereon.

b. Source and Origin of Goods and Services

Goods and services, except for ocean shipping, financed by A.I.D. under the project shall have their source and origin in the Cooperating Country, in the United States and in countries included in A.I.D. Geographic Code 941 except as A.I.D. may otherwise agree in writing. Ocean shipping financed by A.I.D. under the project shall, except as A.I.D. may otherwise agree in writing, be financed only on flag vessels of the United States or the Cooperating Country.

c. Initial Conditions Precedent to Disbursement for the Grant and the Loan

(1) Establishment of the Project Coordination Committee, Provincial Operations Committees, and first site team designated.

(2) Project Manager Appointed.

d. The following waivers to A.I.D. regulations are hereby approved:

(1) Proprietary Procurement for 8 American Motors Jeep Vehicles.

(2) Section 636(i) of the FAA of 1961 for 38 locally manufactured small (less than 125 cc) motorcycles.

Signature:_____

Title:_____

Date:_____