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LAM NAIM OON
INTEGRATED RURAL
DEVELOPMENT
PROJECT

FINAL EVALUATION

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ABBREVIATIONS

BAAC	BANK FOR AGRICULTURE AND AGRICULTURAL COOPERATIVES
BOI	BOARD OF INVESTMENT
B-C RATIO	COST-BENEFIT RATIO
CDD	COMMUNITY DEVELOPMENT DEPARTMENT
CHO	CONSTANT HEAD ORIFICE
DOA	DEPARTMENT OF AGRICULTURE
DOAE	DEPARTMENT OF AGRICULTURAL EXTENSION
DOF	DEPARTMENT OF FISHERIES
ECON.	ECONOMIC INSTABILITY INDEX
FIN.	INTERNAL RATE OF RETURN
IRR	INTERNAL RATE OF RETURN
JPPCC	JOINT PUBLIC - PRIVATE SECTOR CONSULTATIVE COMMITTEE
LMC	LEFT MAIN CANAL
LNO	LAM NAM OON
LOC	LAND CONSOLIDATION OFFICE
MINT	MINISTRY OF INTERIOR
MOC	MINISTRY OF COMMERCE
MOAC	MINISTRY OF AGRICULTURE AND COOPERATIVES
MOE	MINISTRY OF EDUCATION
MOI	MINISTRY OF INDUSTRY
MSTE	MINISTRY OF SCIENCE, TECHNOLOGY AND ENERGY
NESDB	NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD
NESSI	NORTHEAST SMALL-SCALE IRRIGATION PROJECT
NFE	NON-FORMAL EDUCATION DEPARTMENT
OAE	OFFICE OF AGRICULTURAL ECONOMICS
O&M	OPERATIONS AND MAINTENANCE
RID	ROYAL IRRIGATION DEPARTMENT
RMC	RIGHT MAIN CANAL
RTG	ROYAL THAI GOVERNMENT
SAT	SPECIFIC ASSIGNMENT TEAM
USAID/AID	UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

1. Executive Summary

PROBLEM AND OVERVIEW: The Lam Nam Oon area, like most of Northeastern Thailand, suffered from severe poverty due to a low level of agricultural productivity. Poor soils, frequently inadequate rainfall and periodic floods limited cropping to subsistence levels, with virtually no possibility of cultivation during the dry season. The extreme poverty in the area led to the emergence of a serious insurgent movement in the area. In 1968 the Royal Thai Government (RTG), with financial and technical assistance from USAID, undertook construction of a large irrigation system covering approximately 30,000 hectares. The 3.5 kilometer earth dam for this system was completed in 1973.

U.S. ASSISTANCE: The RTG requested additional assistance in 1974 to complete the down stream portion of the irrigation system. As initially designed, the Lam Nam Oon Integrated Rural Development Project (AID Project No. 493-0272) was intended to make possible substantial dry season cultivation by completing the main and lateral canal systems, constructing the on-farm distribution and drainage network and improving the operations and maintenance of the irrigation system at both the above-farm and on-farm levels to promote overall rural development through an integrated approach, involving community development, agricultural research and extension, adult education and public health services. USAID financial support (Loan No. 493-T-020) amounted to US\$3.5 million at the termination of the project. Technical assistance was provided to the Royal Irrigation Department (RID) by a team of expatriate consultants consisting of a rural development specialist, an irrigation engineer and an agricultural economist/marketing specialist. From time to time these personnel were supplemented by short-term consultants in various fields

PURPOSE OF EVALUATION: This is the final project evaluation. It is intended to determine the extent to which the goals of the project were met and includes an analysis of the approaches used during the project as well as recommendations for improving the performance of the irrigation system and agricultural development, particularly as this concerns private sector participation in the on-going agricultural marketing program at Lam Nam Oon. The evaluation team reviewed project documents, conducted extensive interviews with officials in Bangkok and at the project site, interviewed residents of the project area (particularly the heads and selected members of water user groups, who are responsible for on-farm water management), attended scheduled weekly meetings of irrigation system zone-men and Special Assignment Teams (SAT) and held in-depth discussions

with representatives of the private sector who are undertaking crop production, marketing or processing activities related to the Lam Nam Oon Project.

FINDINGS:

1. The irrigation system is capable of providing water to approximately 167,000 rai of land in the wet season and 67,000 rai in the dry season. Cropping intensity during the wet season is 100% with farmers planting mostly high yielding strains of glutinous rice and a relatively small amount of non-glutinous rice. The area cultivated during the dry season is relatively small at the present time. However, this area has been as high as 26,000 rai (1980/81) and as low as 3,000 rai (1984/85). Causes of the fluctuation appear to be the lack of experience of Lam Nam Oon farmers with dry season cultivation and the absence or instability of markets for dry season crops.

2. In January 1982 the project objectives were revised to focus on water delivery and on intensifying irrigated agricultural production. These objectives, specified in Project Implementation Letter No. 14 (January 27, 1982) consisted of:

- 314 kms. of main and secondary irrigation channels, 178 kms. of drainage channels

- development of a long-range plan for land development

- completion of 90,500 rai of on-farm land development

- testing of alternative on-farm irrigation models (including the RID and Lam Nam Oon models)

- operation and maintenance of irrigation system according to plan developed by RID project staff and USAID consultant

- revised agricultural research program emphasizing cropping patterns and integrated farming systems with at least 100 2-rai test plots in operation

- trained RTG personnel providing technical assistance and information to farmers regarding on-farm water management and irrigated crop practices

- 18 families in the Nam Oon Self-Help Land Settlement trained in silk production practices

- increased fish production for food and income purposes realized from fish cultivation and villager training programs

The End of Project Status (EOPS) specified in Project Implementation Letter No. 14 has been substantially achieved. Although, in the case of the 100 2-rai test plots only the physical facilities were completed. In only a few instances were these plots cultivated.

3. Operations and maintenance of the above-farm irrigation system has improved and become more systematic. The physical facilities are in generally satisfactory condition and are able to supply irrigation water at designed quantities. There is a persistent shortage of maintenance funds due to national budgetary constraints which may be cause for concern in the future. A computerized water management system has been developed and is being tested. Full-scale tests will begin in June 1986. This system promises to improve the efficiency of the irrigation system, particularly as the area under dry season cultivation expands and requires the rotation of water supplies on a scheduled basis.

4. A core group of agencies - RID, the Community Development Department, the Office of Land Consolidation, the Department of Fisheries and the Department of Agriculture - continue to cooperate closely in operations and planning at Lam Nam Oon. Other agencies such as the Department of Non-Formal Education and the Department of Agricultural Extension appear prepared to continue their cooperation but are constrained by limited budgets for activities outside of their nationally mandated programs.

5. A number of agro-business firms have undertaken commercial or pre-commercial activities in the Lam Nam Oon area to produce crops for industrial processing and the production of seed for domestic use and export. This is partly the result of marketing activities carried on by the Lam Nam Oon Project staff and partly the result of the natural suitability of Lam Nam Oon for agro-industrial activities. Other firms have expressed interest in crop production or processing activities at Lam Nam Oon, but this will depend on the degree of support they can expect from the government in initiating these activities, many of which may be uneconomic in their initial stages.

6. As a result of this project, RID has come to realize that it can no longer focus solely on the infrastructure aspects of its

irrigation projects, but must also take the initiative in inducing the cooperation of other agencies needed to insure that the infrastructure is used productively. To this end, RID is in the process of establishing an internal unit to promote such cooperation and to manage four model irrigation projects to demonstrate the necessity of integrated or policy coordinated approaches to agricultural development.

PROJECT DESIGN AND POLICY IMPLICATIONS: Earlier evaluations of the Lam Nam Oon Project tended to be negative, focusing on the failure to meet expected agricultural production targets, the physical deterioration of the irrigation system or the lack of effective cooperation among participating government agencies. The achievements made over the past five years suggests that previous evaluations may have been premature in reaching their conclusions. The introduction of new technology, such as irrigation, new crops and cropping practices, and the development of linkages to the private sector for marketing and processing of commodities into an area of largely subsistence farming seems to take much longer than had been expected by the original proponents of the Lam Nam Oon Project. Experience with large irrigation projects elsewhere in the world, including the United States, indicates that few projects achieve their objectives or function at an optimal level until they have been in operation for ten to twenty years.

This suggests that the proponents of a project (particularly a large and complicated project such as LNO) should adopt a strategic orientation to its implementation. That is, the phases of the project should be anticipated and the types of activities appropriate for each phase should be noted. Moreover, the time required for the completion of each phase or the conditions which mark the change from one phase to a subsequent phase should be indicated. This would permit project implementors to determine more effectively what has been accomplished and what remains to be done to achieve project objectives. The LNO project did not begin with a strategic orientation, but over the course of the project one gradually evolved and has been accepted by the RID. The evaluation team concludes that had a strategic orientation existed from the outset, particularly with the inclusion of a recognition of the need for private sector involvement in dry season crop production and marketing and a program for generating this involvement, the economic returns of the project would have been substantially greater. Nevertheless, a good foundation for further progress has been established.

Goal of Strategic Initiative

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Technical assistance to large scale infrastructure projects should be predicated, at least in part, on whether the host government has adopted a strategic orientation to the use of the infrastructure and is prepared to provide the long-term management support needed to implement the strategy.

RECOMMENDATIONS:

1. Irrigation systems, particularly large systems such as Lam Nam Oon, should constitute a distinct category of area for the purposes of annual budgetary planning. These systems should be classified in a way similar to the "poverty" areas under the Fifth Five-Year Plan or to the "backward and progressive" areas to be used under the forthcoming Sixth Plan. That is, their character as irrigation systems, with needs somewhat different from the areas which surround them, should be taken into account by agencies when preparing their annual budget proposals. Guidelines issued by the National Economic and Social Development Board, in consultation with RID and other agencies, would help provincial development committees to review the budget requests of provincial offices prior to forwarding them to their parent agencies. Such a system would encourage coordination by requiring agencies to adopt a common frame of reference in defining their goals.

2. Water user groups are essential for performing operations and maintenance tasks on the on-farm water distribution network and to the management of water for dry season cultivation. Experience at Lam Nam Oon has shown that the water user groups function effectively at the present time, but they are far from using the irrigation system to its full potential. As they increase their use of the system and intensify their cultivation, their water management burden and their need for more sophisticated cropping techniques will grow. Therefore, there is a need for a long term program of technical support and training for water user groups. More importantly, there is a need to develop a system to support second generation irrigators (the children of the present farmers) both in terms of the technical aspects of irrigation and irrigated agriculture, but also in terms of developing a more commercial orientation toward agriculture. The Ban Fang Daeng Integrated Rural Development Training Center (under the Community Development Department) has been responsible for the basic and supplementary training of water user group members, and has a modest program for the training of women and youth in various aspects of irrigated agriculture. This activity should continue, but additional programs should be incorporated in the curriculum of local elementary schools, vocational schools and the provincial Office of Non-Formal Education.

3. The only opportunity for a significant expansion of dry season agriculture at Lam Nam Oon is by developing commercial outlets for crops. This means developing permanent linkages with individual middlemen and private sector agro-business firms engaged in processing or marketing activities. The marketing review indicated important local area marketing opportunities for a variety of crops, as well as numerous opportunities for production for export. The RTG should adopt measures to encourage investment by such business at Lam Nam Oon and the introduction by such investors of new agricultural technologies needed for the production of significant volumes of high quality commodities.

4. The introduction of a computer-based water management system at Lam Nam Oon is a major innovation in irrigation systems in Thailand. Support should be given to the development and improvement of this system, particularly since successful dry season agriculture at Lam Nam Oon will require the management of multiple crops, with complex water distribution schedules. If adequate water management is not assured, private sector investors will be deterred from undertaking activities at Lam Nam Oon.

5. Export promotion and the decentralization of industrial production are basic policies of the RTG. Therefore, the possibility of offering privileges to firms which invest in irrigation projects, such as Lam Nam Oon, should be explored with the Board of Investment.

COMPOSITION OF THE EVALUATION TEAM:

The evaluation team consisted of Dr. Warin Wonghanchao, Director of the Chulalongkorn University Social Science Research Institute (CUSSRI); Dr. Amara Pongsapich, Deputy Director of CUSSRI; Dr. Prakob Wirojanagud, Assistant Professor of Engineering, Khonkaen University; Mr. Anthony Zola, Agro-Economic Advisor, Thailand Development Research Institute; and Dr. Thomas Morgan, Organization and Planning Systems Analyst, PADECO (Thailand), Ltd., who served as team leader.

2.0 Analysis of Findings and Recommendations

2.1 Introduction. The evaluation team reviewed documentation on the Lam Nam Oon (LNO) project both at the Bangkok offices of USAID and at the project site. A bibliography of this documentation is attached to this report. Of particular help to the team were the various operations research, agronomic and economic reports prepared by the project consultants, as well as the various monitoring and evaluation reports prepared by the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, and special studies commissioned by USAID on maintenance activities at LNO.

The objectives of the LNO project have evolved over the years since the project was conceived in 1964. In particular, the objectives underlying USAID support of the project became more clearly focused during the course of the project. This report focuses on the evaluation of the LNO project in light of these refined objectives as reflected in the Terms of Reference.

2.2 At the outset of the project in 1978/79 the main irrigation system had been completed and work on the on-farm water distributic system was just beginning. In the absence of any dry season demand for water and only supplemental irrigation in the wet season, the operations burden on project staff was minimal. Due to the previous emphasis on construction of the main and lateral canal systems and the commencement of the construction of the on-farm system, maintenance was not given the

attention it warranted. Serious siltation was taking place in the canals together with substantial deterioration of the canals due to neglect and misuse on the part of farmers.

2.2.1 A report on LNO maintenance in 1982 noted a substantial number of serious problems involving both the condition of the system and maintenance procedures. Particular attention was given to the poor performance of water user groups and the report called for a ten-year program of technical assistance to improve their agricultural and on-farm water management practices.

In the ensuing three years there appears to have been major improvement in the maintenance picture. There continue to be obvious cases of deterioration in the linings of the main canals and laterals. Weeds and sediment are also common. In some cases the condition of on-farm distribution systems appears deteriorated. Nevertheless, both the above-farm and on-farm systems remain able to convey water in the amounts needed. Almost all of the required water user groups have been formed and, in the vast majority of cases, participate in the distribution of water and in carrying out maintenance on farm ditches. There are a few instances where water user groups imposed fines or other sanctions on members who failed to assist in the maintenance of ditches.

While water user groups are important to the functioning of the irrigation system, the time and labor burden

they must bear as a group is not at all onerous. Most groups interviewed reported between two to four days of maintenance work per year to clean and repair on-farm ditches. The organizational requirements for this maintenance are minimal, consisting of a brief meeting of group members to determine a convenient time to carry out the work. Maintenance is usually done twice each year, shortly before the onset of the rainy season and before dry season crops are planted.

2.2.2 The dry season cropping intensity at the present time is quite low and the amount of water available is far greater than demand. As a result, farmers may not be learning to be efficient in their use of water. There does appear to be a tendency for LNO farmers to use excessive amounts of water, and numerous cases were found where farmers had flooded their fields, but planted no crops. The reason for this was that they felt better knowing they had water. Excessive water use in the dry season, whether for crops or psychological satisfaction, will increase the salinity of the soil, which is already a serious problem at LNO. In the absence of widespread cropping, there may be no way for LNO farmers to learn the behavioral patterns required for efficient on-farm water distribution. There are already instances where some farmers at the heads of ditches have diverted excessive water into their fields. It was alleged by officials that this was sometimes due to the farmers' anxiety over water supply and sometimes due to selfishness and their ability to take better advantage of the on-farm network. While the water user groups appear to function well for the

purpose of routine maintenance and even on rare occasions impose sanctions on members, there is no clear evidence that they have developed the degree of solidarity needed for effective water management.

2.2.3 The maintenance procedures of the LNO O&M staff have improved markedly over the period of the project. Urgent problems are dealt with promptly and assistance is provided to water user groups in performing maintenance work. On occasion, cement has been provided to groups to repair ditch linings and project staff have been sent to assist on difficult work. The managers of LNO also try to minimize the impact on farmers who are cultivating during the scheduled annual maintenance on the canal network. Normally such maintenance requires the canal to be shut down for about a month each year. Where possible LNO managers continue to provide water to these farmers when maintenance is not being carried out, such as in the evenings or on weekends.

Official maintenance budgets continue to be inadequate for proper maintenance. The Deputy Director General for Maintenance at RID estimates that funds for maintenance at LNO are far below optimum levels. Standard maintenance costing methods call for the LNO project to receive 25 baht per rai for administrative costs and 100 baht for physical maintenance, while actual allocations are 7 baht and 30 baht per rai respectively. The RID does not anticipate any improvement in the funds it will

have available for maintenance, but feels that improvements in maintenance can be achieved by better management and increased expertise on the part of maintenance personnel.

2.2.4 In order to focus attention on overall project management, including maintenance, the RID is initiating a program for developing four model irrigation systems - one in each region of the country. The department has selected LNO for the Northeast, the Mae Faek project in the North, while the projects for the Central and Southern regions are still under consideration. The RID will attempt to give these projects special support in terms of manpower and funds for maintenance. It has also initiated discussions with the Ministry of Agriculture and Cooperatives (MOAC) aimed at continuing the integrated approach used during the period of USAID support. Under this proposal each MOAC department will be asked to allocate a portion of its annual budget for LNO. It is assumed that this will also apply to the three other model projects. Under this program the private sector also will be encouraged to invest at LNO and the other projects

Traditionally, RID has been responsible for providing and maintaining infrastructure and was not expected or thought itself required to undertake ancillary activities needed to ensure that the potential benefits of these projects were realized. In the past, efforts to effect the coordination of services to irrigation projects involved a hierarchy of

committees and working groups at the national, changwat and project levels. While this structure, particularly the project level working group, functioned moderately well during the period of USAID support, it ceased to exist once the external support was removed. This has been the case in virtually every case of externally induced integration attempted in Thailand. Consequently, RID has decided to establish a special unit to assist in coordinating the inputs needed for project success. This unit, which will be a non-gazetted office at first to avoid the need for Civil Service Commission approval, may later be formally established as a division or the equivalent. This unit will be responsible for the four model projects noted above, and will try to preserve and extend the pattern of integrated rural development employed at LNO.

2.3 Benefits Derived from USAID Activities in Lam Nam Oon.

USAID provided support to the Lam Nam Oon Project between 1978 and 1985. The project was revised in 1982 to narrow the objectives of the project in order to focus on expanding water delivery and use and on intensifying irrigated agricultural production. In conjunction with this revision, it was agreed that twelve conditions would be met by the conclusion of the project. These conditions and the degree to which they have been met are as follows:

2.3.1 314 kms. of main and secondary irrigation channels and 178 kms. of drainage channels will have been completed.

This objective has been met. The above-farm irrigation system has been completed and responsibility for most aspects of the system have been transferred to the Operations and Maintenance Division.

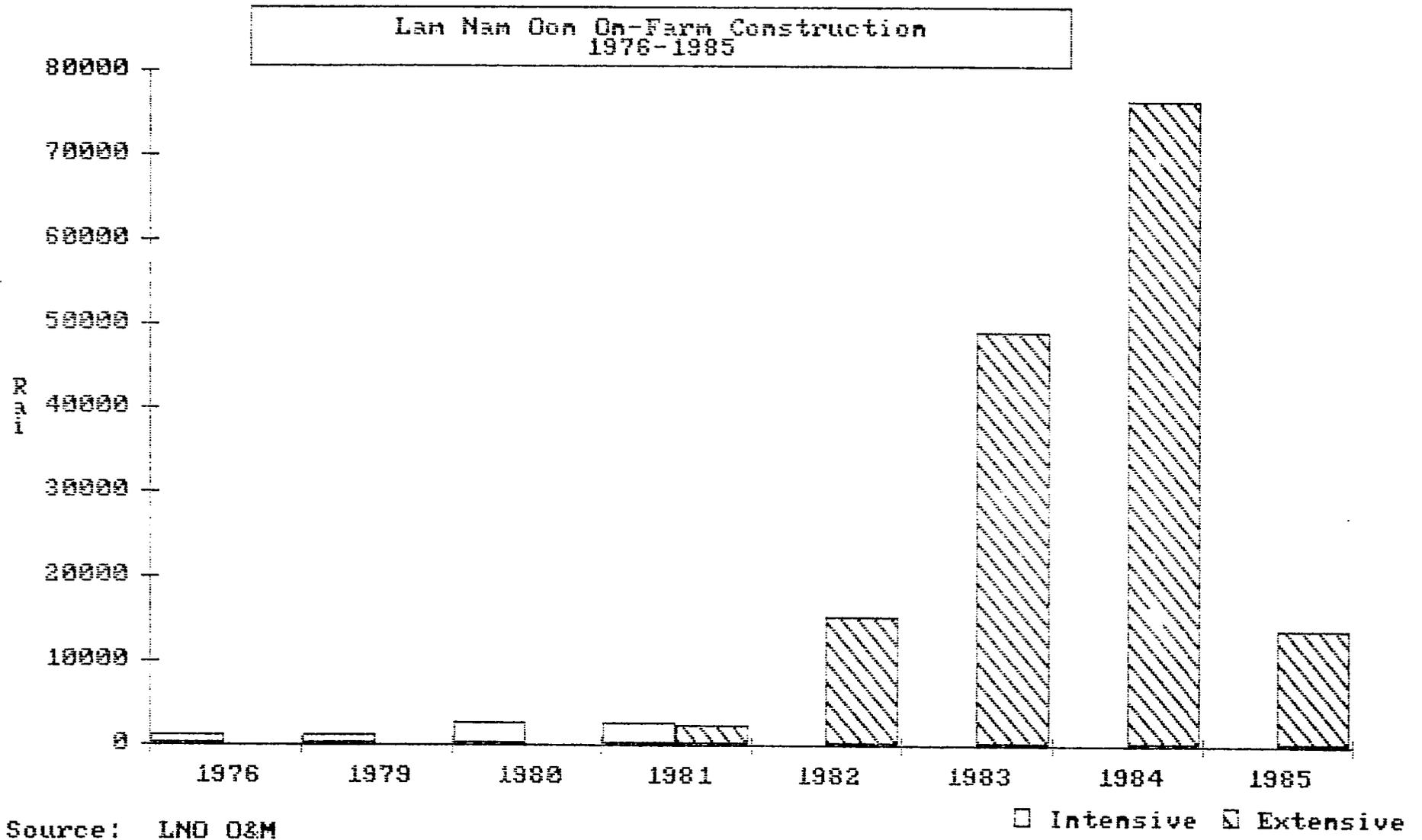
2.3.2 Long-range plan for land development will have been completed.

The consultant team instituted an operations research program to improve the quality of water management and to assess the effects of irrigation on the land in the area. The information derived from this ongoing operations research will permit the RID personnel at Lam Nam Oon to anticipate and plan corrective measures for problems arising from increased irrigation. Among the problems most likely to be encountered is excessively high levels of salinity due to poor on-farm irrigation practices.

2.3.3 90,500 rai of on-farm (irrigation and drainage ditches and related structures) land development will have been completed.

All on-farm land development has been completed with the exception of approximately 1,000 rai which will be completed during the 1986 dry season. This small portion was to have been completed in FY 1985, but was delayed due to weather problems. Contracts for this work have already been signed. See Figure 2.3.3.

Figure 2.3.3



13a

2.3.4 Alternative on-farm irrigation models (including the RID and Lam Nam Oon models) will have been tested.

Three patterns of on-farm water distribution were undertaken at Lam Nam Oon. The first is an intensive model derived from the pattern used by RID in the Central Region. This involved major land leveling, rectangularization of farm plots and long distribution ditches. The second is the ditch and dike model used by RID in areas outside of the Central Region. It does not involve land leveling and leaves farm plots relatively undisturbed. The third, the Lam Nam Oon model, is a modification of the ditch and dike pattern. It differs from this principally in the length of its on-farm ditches. The Lam Nam Oon model uses much shorter ditches, and as a result requires a larger number of irrigation units (called "chaeks") for a given area. In terms of construction costs, the intensive model is the most expensive, averaging over 4,000 baht per rai.

2.3.5 The irrigation system will be operating and maintained according to plan developed by RID project staff and USAID consultant.

Beginning in 1983, the consultant team undertook a program of operations research to improve the management of the above-farm irrigation system. Since regular management had been lacking prior to that time, it was decided to proceed gradually in extending RID control over the system. Operations research, therefore, focused on the Right Main Canal (RMC) which was the longest of the two main canals and which served the greatest

area. The first priority was to attempt to control the rather large fluctuations in the water level of the RMC. Operations Research Report No. 12 details the results of this attempt. The lessons learned during the initial period of operations research continued to be applied after the consultant team was withdrawn in 1985. Data supplied by the O&M Office at LNO shows a significant improvement in the ability to control water levels in the main canals. Prior to 1982 water level fluctuations of a meter above and below the full water mark on the RMC were a common occurrence. The LNO Master Plan (1983-1993) called for a gradual reduction in the extent of this fluctuation from one meter to fifty centimeters by 1985. The current fluctuation is actually only about thirty centimeters - an impressive achievement, and quite satisfactory given the modest degree of dry season cropping at the present time. Nevertheless, as can be seen from the figures in Attachment 2, there continues to be considerable fluctuation in the water level along the RMC.

Four O&M staff have been trained in the use of the water management computer program developed by the consultants. This training has been an essential preparation for further improvements in water management. The Deputy Chief of O&M at LNO has just returned from a one year water management course at Utah State University where he developed a computer program for water management for both the RMC and the shorter LMC. The initial implementation of this second phase of the water management system should commence in June 1986 and undergo tests for at

least one rainy season and one dry season. If these tests are satisfactory, the computerized water management program will be extended to the lateral and sub-lateral canals. The O&M staff anticipates that they will have an operational computerized water management system by 1990/91 and expect that they will be able to develop an operational model down to the farm level by 1993/94. Such a system would be superfluous at the present time, but will become essential as dry season cropping expands. However, unless the above-farm system can be effectively controlled, there will be no possibility of predictable control of the on-farm network.

2.3.6 A revised agricultural research program emphasizing cropping patterns and integrated farming systems with at least 100 two rai test plots.

The Rice Experiment Station in Sakon Nakorn has focused on wet season crops, particularly rice, and has a program to persuade farmers to lessen their production of glutinous rice and to replace this with regular strains of rice for the cash market. The Field Crop Experiment Station was active in the Lam Nam Oon area up to the end of FY 1985, but since the termination of USAID support has had no programs specifically oriented to the project. Other project related expenditures may be included in other budget items, such as research on field crops, vegetable plots and farming research.

Table 2.3.6 (a)

Sakon Nakorn Field Crops Experiment Station
Budget Allocations for Lam Nam Oon

	Baht

1982	209,000
1983	257,580
1984	?
1985	68,000

The Field Crop Experiment Station is focusing its research on groundnuts, soy beans, black matpe, various green beans, corn and cassava. The emphasis is on crops which are suitable for the Sakon Nakorn area, but there appears to be no research which is directed specifically toward the needs of agribusiness. At the present time the station is not conducting any field demonstrations, but is focusing on seed multiplication. This situation may be due to the absence of many of the professional staff who are attending training programs in Thailand and overseas.

a. The DOA representative at the project has also carried out a series of field trials during the period of AID support, and is continuing trials on cropping patterns and fertilizer requirements for various crops. Due to the interest of a number of agribusiness companies in the LNO project area, this DOA representative is also preparing a series of trials of crops and cropping practices which might be of assistance to other firms which are exploring investment opportunities in the LNO area. While these trials are valuable, they appear inadequate to the needs of the LNO area. The market for various

crops now grown at LNO is either limited or inadequately explored. Therefore, there is a need to develop a fairly large variety of dry season crops suitable for the area to minimize the potential for market saturation, and also to permit farmers a degree of flexibility in varying crops to take advantage of changing market conditions.

b. According to the revised plan for LNO contained in Project Implementation Letter No. 14, one hundred two-rai test plots of mixed farming systems were to have been completed by the end of the project. This target has been achieved as shown in the following table.

Table 2.3.6 (b)
Establishment of Mixed Farming System Test Plots
1982-85

Year	Number Constructed
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1982	11
1983	26
1984	17
1985	46

The capacity of mixed farming systems to supply the basic subsistence needs of a family has been demonstrated in areas outside of LNO. These systems also have the capacity to generate cash income, if they are used to cultivate various vegetable and fruit crops. Observations in the field and subsequent discussions with LNO officials indicated that these

plots are not being used to anywhere near their potential, and most are not being used at all. While all of the test plots observed contained ample water in their ditches, none were used to grow more than a few banana plants or some household vegetables, and most were covered only in weeds. LNO officials noted that while crops were not grown in most cases, many of these mixed farm plots were used to raise fish for home consumption, and that this was a major motivation of the farmers who accepted to participate in this program.

The team was not able to determine clearly the causes for the poor utilization of these mixed farming plots by means of a systematic survey. However, several factors seem to have been influential. First, nearly half of these plots were recently constructed. Participating farmers might not have been able to prepare their plots for cultivation while also occupied with the wet season rice crop. It was also reported that farmers often do not see the purpose in planting a variety of crops on the same land. They would prefer to grow a single crop. Another factor mentioned was fear of theft. Since these plots generally are located at some distance from the village, the owners felt that they could not protect their crops and fish from being stolen. Moreover, the sites for the mixed farm plots were chosen on the basis of their suitability for this type of farming, rather than because of demonstrated interest on the part of farmers. Since the plots were essentially free, farmers may not have given sufficient thought to the practical aspects of mixed farming technology.

Some LNO officials feel that use of these mixed farm plots will increase as farmers become more aware of their potential. To this end, the DOA representative at LNO has planned tests of suitable crops, such as lychees, cashews and asparagus. Although the introduction of these mixed farming plots at LNO may be an example of a technology introduced before its time, it appears that insufficient attention has been given to this experiment.

2.3.7 Trained RTG personnel will be providing technical assistance and information to farmers regarding on-farm water management and irrigated crop practices.

Personnel assigned to the Lam Nam Oon project are providing regular assistance and information to farmers concerning irrigated agriculture and water use. DOAE personnel assigned to the LNO area were reported to be more active than DOAE personnel elsewhere in the province because the potential for dry season cropping was greater. The eight additional DOAE extension workers hired with USAID support have been retained. DOAE staff are concentrating on promoting the major dry season crops grown at LNO, particularly groundnuts, corn and vegetables.

All the leaders of water user groups and many members have completed the basic course in irrigated agriculture and water use at the Ban Fang Daeng Center in Phang Khone District. The center also provides training to womens' and youth groups with a focus on irrigated agriculture. In addition, each of the

zonemen is in daily contact with farmers and advise them on proper water use for the crops they are raising. The zonemen also report weekly to the O&M Chief on the crop and water use situation in their zones. At these meetings they also indicate the water requirements for their zones for the forthcoming week. While zonemen receive periodic training at the Lam Nam Oon Project Training Center, these weekly meetings are also very important because they permit the zonemen to discuss on a regular basis practical issues and receive immediate feedback from senior O&M personnel. The project field office also employs its own extension workers. These workers, called the Special Assignment Team (SAT), are discussed below.

2.3.8 Eighteen resettlement area families were to be trained in silk production practices.

There are eighteen resettlement area families officially participating in the silk production program of the settlement. However, only seventeen families are now producing silk and of these only sixteen families produce on a regular basis. Normally, six to seven cycles of silk worms can be raised in the dry season. This was achieved in 1984, but in 1985 only one cycle was raised because of shortage of mulberry leaves. Production of mulberry leaves by participating families is so poor that the settlement office plans to centralize the growing of mulberry on its own plots and to use silkworm raisers to tend these plots. It is felt that this will help to increase the volume of cocoon production. This land settlement office, unlike

others in the Northeast, does not have a sprinkler system for its mulberry plots, because it is not part of the regular Public Welfare Department silk program.

In 1984 250 kilograms of cocoons were produced and were sold to the Udorn Silkworm Rearing Promotion Station for 100 baht per kilogram. The agricultural advisor at the settlement who was responsible for the silk program said that silk production at the settlement was quite low. Satisfactory production would be about twenty-five kilograms per family per year. The number of families raising silk worms has not grown in part because the BAAC refuses to grant loans for silk raising in the settlement, claiming that production is unacceptably low.

2.3.9 Increased fish production for food and income purposes realized from fish cultivation and villager training programs.

The Sakon Nakorn Fisheries Station has completed 200 one rai fishponds during the period of USAID support, and plans to continue to carry on the program. Originally, the station was able to maintain a construction rate of over 60 ponds per year using its own bulldozer. This machine is now being repaired, but due to its age officials feel that it will be capable of only 30 ponds per year after returning to service. In addition to these ponds, 672 fishponds were produced with soil excavated during the on-farm development. A large number of ponds of various sizes have been dug by farmers using their own resources. The

fisheries station did not have figures on the number of such ponds, but discussions with villagers said privately developed ponds were quite common.

Local residents have long fished in the canals of the irrigation system, or have attached fish traps to CHO outlets. This practice has caused damage to the canals in the past, but appears to have been reduced over the past several years. However, there are reports that non-residents continue to use the canals for fishing and even bring in pickup trucks at night to carry their catch away.

The fisheries station has released fingerlings into the Lam Nam Oon reservoir annually since the beginning of the project. A drop in the fish catch has been noted in the past year, but officials believe that this is not due to a fall in the fish population, but rather to incomplete data gathering by the station. Previously there was only one fish landing on the reservoir, so it was easy to collect figures on commercial fishing. However, several more fish landings have been opened by businessmen at other places on the reservoir which makes monitoring difficult. There is also significant price competition among the operators of the landings with the result that the original landing has reduced its purchases from fishermen.

Three patterns of fishing are found in the reservoir. The first is subsistence fishing by local residents. The amount of subsistence fishing is not known, but is not felt to put serious pressure on the fish population. The second type is commercial fishing sponsored by businessmen who run the fish landings. This fishing is not effectively monitored, so its effect on the fish population is also not known. The third type is poaching by organized groups of fishermen who use explosives, have boats with powerful motors and who are armed with automatic rifles. These persons were reported to be military and militia personnel, but this allegation could not be confirmed. The Department of Fisheries is not able to police the reservoir effectively, because it lacks sufficient manpower.

Officials of the Sakon Nakorn Fisheries Station noted that they are not even able to supervise the Nong Han reservoir which is adjacent to the changwat capital. Nevertheless, in the LNO area the fisheries station continues to be active and has increased its staff serving the area from three to four officials.

Since the fisheries program at LNO was initially intended to meet subsistence needs, the fisheries station did not maintain records on production costs or volume in the project area. However, OAE estimates (1983) that farmers were able to produce 123 kilograms of fish per rai. While much of this is consumed by the farmers households, fisheries officers assigned

this production an equivalent value of 3,000 baht, assuming a price of 25 baht per kilogram. This production level is too low for commercial fish farming - the new emphasis of the Department of Fisheries. Commercial fish farming will require agricultural credit and so fisheries officials contacted the BAAC for assistance. The BAAC wants to support only new pond development - a policy which would exclude the many ponds already developed by the fisheries station. Moreover, the BAAC has adopted criteria that ponds must produce at least 900 kilograms of fish per rai in order to qualify for loans. This production level has been reached by some ponds in Udorn, but the director of the fisheries station felt that such a target was not realistic for the LNO area at the present time.

2.3.10 Effectiveness of Special Assignment Teams

In addition to the zonemen, the Lam Nam Oon Project has fielded a Special Assignment Team (SAT) of twenty-nine temporary-hire personnel to maintain close contact with farmers and provide assistance concerning problems of water use and cropping practices identified by the senior project staff. The SAT are for the most part upper vocational school graduates. They receive extensive training by project staff both in the LNO area and elsewhere, and regular reinforcement at monthly meetings. While not considered experts, SAT members appear competent to carry out the instructions of the senior staff. Talks with leaders of nineteen water user groups suggest that aside from

their contacts with personnel assigned the LNO project, including the SAT, farmers receive no assistance concerning water use.

2.3.11 Review of the NESSI Audit Report and assess adequacy of O&M funding for LNO in light of the Audit Report recommendations.

The 1984 Audit Report (p. 12) of the Northeast Small - Scale Irrigation Project (NESSI) by the USAID Office of the Inspector General pointed out that the widespread neglect of maintenance has caused serious deterioration in most irrigation systems, resulting in low efficiency rates (below 50%) and in the need for premature rehabilitation. It cites a 1981 U.S. General Accounting Office report which said that the LNO irrigation system had deteriorated to such an extent that it could not meet anticipated water delivery requirements. The 1984 Audit Report was especially critical of the policy of allocating a fixed percentage of annual construction costs to operations and maintenance.

These observations and criticisms of irrigation system maintenance at LNO were generally valid at the time, as was the observation (p. 13) that donor agencies have contributed to the problem of inadequate operations and maintenance by their policy of requiring that recurring costs, including O&M, be borne by the host government. The report suggests that ways may be found to shift some of the O&M burden to the donor agencies, in this case USAID. Such a shift might be necessary in the case of NESSI

which has a demonstration role in the development of small-scale irrigation systems in the Northeast. However, it would be even more appropriate to consider ways to support the O&M effort at LNO because this project has already shown that considerable improvement can be made in O&M within the severe constraints of a low budget and limited manpower. Modest external assistance to O&M at LNO might help to determine a minimum acceptable level of maintenance sufficient to insure a given level of agricultural production potential.

The maintenance to be performed at LNO should not be geared to a level that insures water supply for the full agricultural production potential of the project area, but rather should be determined on the level of maintenance needed to keep the basic system intact, while guaranteeing an adequate water supply to a modest increment above the anticipated cultivated area expected for the next two to three dry seasons.

2.3.12 Review of the integrated approach of LNO.

The integrated approach employed at LNO needs to be examined from several perspectives. The first is the rationale that underlay the approach. The second is the manner in which the integration was effected. Third, is the effects of integration on the participating agencies and on furthering the objectives of the project.

The attempt to develop the Lam Nam Oon area began with the rather straight-forward idea of using irrigation to increase the level of agricultural productivity of the land and hence the income and living standards of the people of the area. A package of measures was needed to prepare farmers to adopt and use the new technology. Therefore, in 1978 a new initiative was introduced called the Lam Nam Oon Integrated Rural Development Project. After two years of operation it was realized that little progress had been made in improving water delivery or in raising the intensity of agricultural production.

The project was redesigned to include only those agencies and activities which made a functional contribution to achieving these two goals. This change was formalized in Project Implementation Letter No. 14, dated January 27, 1982, but was in fact based on developments which had already begun to be made by the staff and consultants working in the project. One of the most important features of the revised integrated approach was the use of working group comprised of mid-level officials of the participating agencies to coordinate technology transfer activities. Working groups are most often formalistic and seldom contribute anything to project management. The working group at LNO was very different. The members met every month and took an active interest in the course of the overall project, not merely those areas where individual members had operational responsibility.

The agencies represented by working group members were provided with supplementary funds from USAID. While individual members showed personal interest in the project, it is clear that in the absence of these extra funds, the various agencies would likely not have made their personnel available to the project. In fact, when USAID ceased its contribution in September 1985, the working group also dissolved, with the exception of a core group belonging to the Changwat Land Consolidation Office, the DOA, CDD and RID. Nevertheless, the project field director has continued to maintain communication among the agencies. Moreover, the chiefs of the changwat offices of these agencies have indicated a desire to continue to support the project within the constraints imposed by their budgetary allocations and the policies of their parent departments.

One of the most important effects of the working group at LNO was to bring RID to a recognition that in developing irrigation systems it must look beyond the mere construction of the infrastructure to the issue of how to insure that the infrastructure is used effectively and to a recognition that RID must bear a major burden of responsibility for inducing the cooperation of the agencies needed to make this possible.

There is no indication that this integrated approach divided the time of project staff or diverted them from their principal duties. However, the A.I.D Evaluation Working Paper No. 46 (September 1982, p. xi) by Robert Muscat observed that "The integrated rural development activities were viewed by the

Mission as diverting the time of Mission staff and of the advisory team leader away from the irrigation problem."

The integrated approach used at LNO does not differ fundamentally from that used in other projects in Thailand. In itself, it did not result in or impair a balanced and efficient implementation of the project. Most of the activities performed by the various agencies involved could have been performed in isolation from one another and without an integrating mechanism, if the officials of these agencies were sufficiently sensitive to the program requirements made necessary by the local environment. However, to a major extent local officials are required to orient their activities in terms of priorities determined by their parent agencies. The integrated approach helped to mitigate this orientation somewhat, but could not result in a permanent shift in focus. The inducements to such a change (USAID support funds) were relatively small and largely of local impact. There is no evidence, except in the cases of CDD and RID, that there was any modification in the orientation of the central administrations of the participating agencies toward programatic support of irrigated agriculture.

2.4 Factors which limit access to water in the LNO irrigation system.

Within the design constraints of the system there appears to be virtually unrestricted access to water in both the rainy and dry seasons. Since the completion of the on-farm ditches and related structures, RID is able to provide water to

approximately 60,000 rai of land in the dry season. Of this area only a few isolated chaeks have experienced persistent difficulty in receiving water. The causes of this difficulty are not yet clear, but several possibilities were mentioned by both affected farmers and RID officials.

2.4.1 First, and most likely, is that the few water user groups which received inadequate water were located near the ends of rather long lateral or sub-lateral canals. Farmers higher on the canals diverted enough water during the dry season so that little was able to reach the tailenders. RID officials noted that adequate water could have been provided by pumping additional water into the laterals, but that based on projected cropping in the lateral service areas concerned, the water provided was sufficient. This problem seems limited to areas outside the natural Lam Nam Oon watershed where water must be transported over the watershed boundary by one of four pumping stations. Due to the cost of electricity for operating the pumps RID has adopted the policy that if less than 50% of the farmers in a chaek decide to raise crops in the dry season (especially if plots are widely scattered) they will not be provided with water. However, if the planted area is clustered at the head of a chaek less than 50% will be acceptable.

2.4.2 Second, it is possible that design or construction errors may limit farmer access to water. This problem was raised by one water user group on the lower reaches of the RMC. The validity of this claim could not be confirmed,

but the Deputy Chief of O&M said he would personally investigate the claim.

2.4.3 Third, at the present time the area cultivated in the dry season is quite small - under 10,000 rai. At this level of cropping, there is sufficient water for all those who wish to cultivate. In the future, if the area cultivated in the dry season grew substantially, access to water might be restricted by the need to share water equitably. This likelihood puts a premium on perfecting the water management system at the farm level.

2.5 Wet and Dry Season Agriculture at Lam Nam Oon 1980 through 1986

2.5.1 Wet season agriculture at LNO is almost exclusively devoted to rice cultivation. Of a total irrigable area of 185,800 rai, about 167,200 is planted in various strains of glutinous and non-glutinous rice. Between 1978 and 1981 sizeable areas also were planted in rice during the dry season. This practice is highly wasteful of irrigation water and with increased wet season production is not necessary to meet subsistence requirements.

Due to vigorous efforts by local officials, the introduction of higher yielding varieties of rice and the increasing experience of area farmers, dry season rice

cultivation has been virtually eliminated [see Table 3 (b) Attachment C].

Rice varieties planted in the wet season consisted of various government promoted strains of both glutinous and non-glutinous rice, as well as a small number of local varieties. A sample of farmers surveyed by OAE found the following varieties and percentages of area devoted to each. It is evident that despite the readiness of farmers to accept government promoted varieties of high-yield rice, they still have strong preference for glutinous over non-glutinous rice.

Table 2.5.1

Rice Varieties and Area Planted
LNO - 1984/85 Wet Season

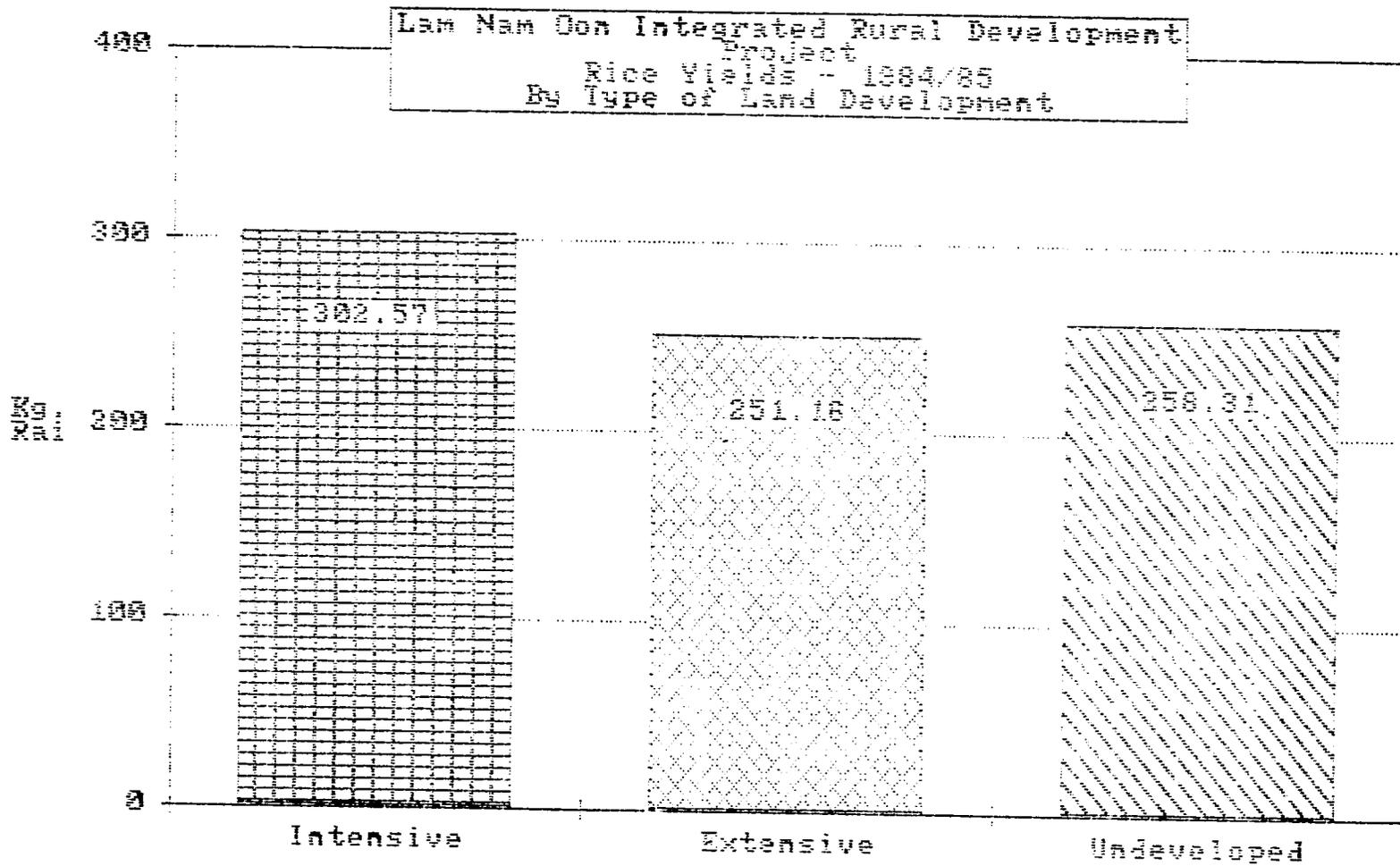
Variety	% of Area Planted

Glutinous	
Ko Kho 6	68.16
Ko Kho 8	.78
Ko Kho 10	.05
Niew Mali	3.97
Other Govt. Promoted Glutinous Varieties	13.24
Local Varieties	4.69
Non-Glutinous	
Ko Kho 7	.06
Ko Kho 23	.22
Mali	8.04
Other Govt. Promoted Non-Glutinous Varieties	.06
Local Varieties	.73

	100.00

Source: OAE

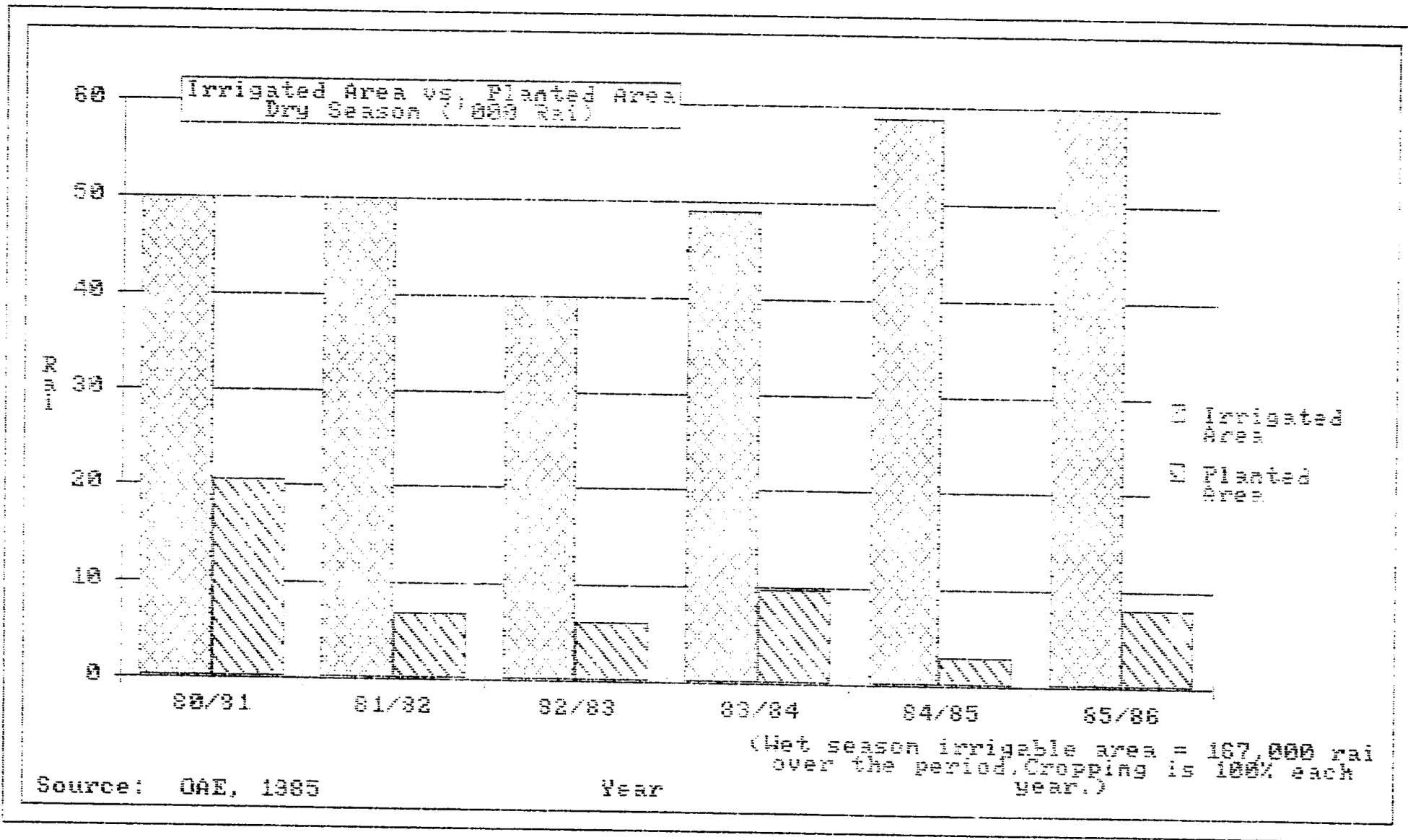
Figure 2.5.1



Source: OAE, 1986

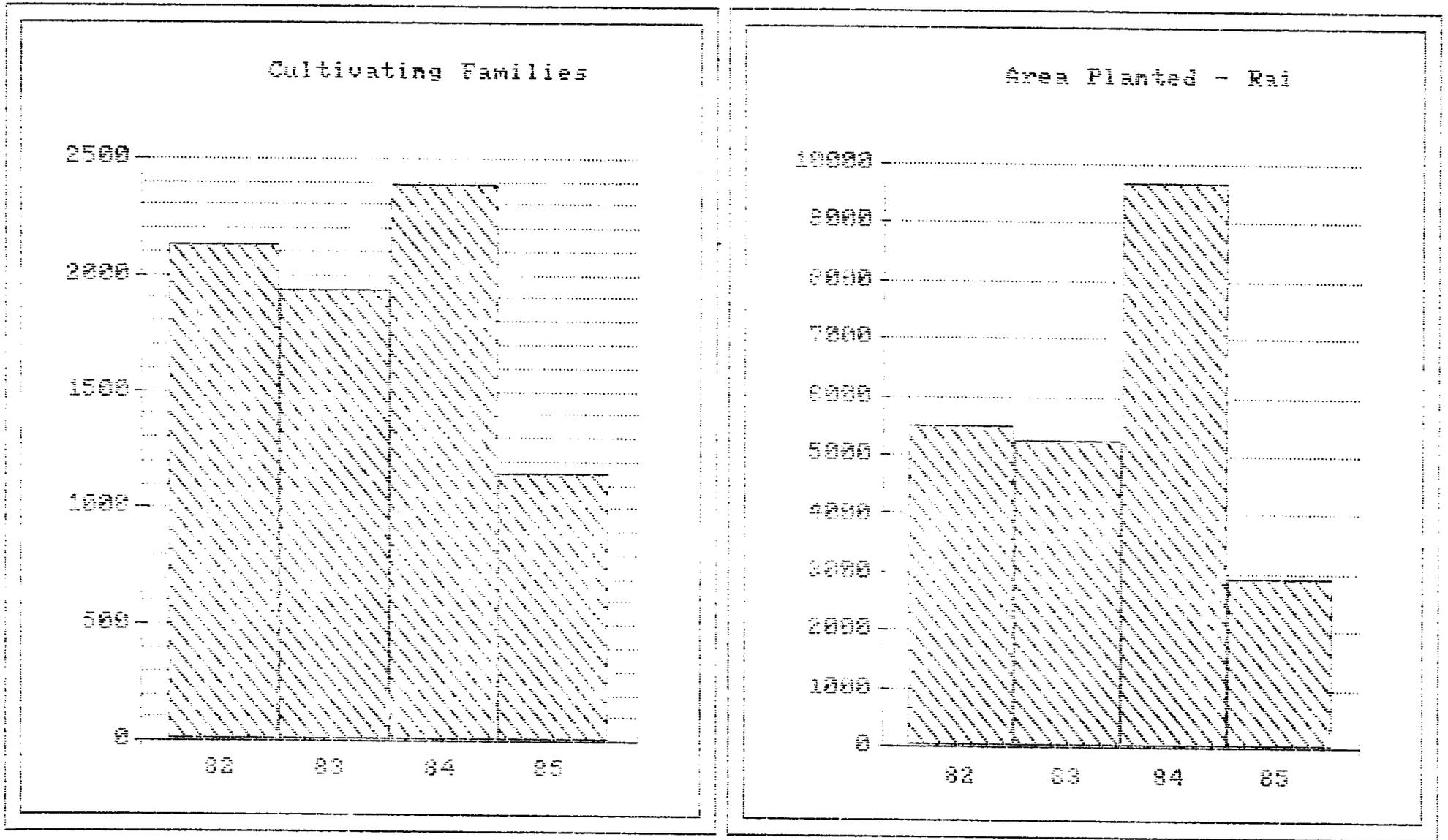
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Figure 2.5.2 (a)



23

Figure 2.5.2 (b)



25

The OAE study also found that those farmers who continued to plant local varieties tended to be those who farmed areas where the on-farm water distribution network had not yet been constructed. The report observed that those in areas which had on-farm systems more readily accepted newer technologies. This point ought to be investigated further. An alternative explanation is that those farmers who grew local varieties were merely playing it safe, because they knew the amount of production they could get under existing conditions.

Figure 2.5.1 above shows average rice yields for LNO for the 1984/85 wet season for intensive, extensive and as yet undeveloped areas. It is interesting to note that yields in the undeveloped areas were marginally higher than those in the intensive areas. This was attributed to a higher level of fertilizer application in the undeveloped areas. It also suggests that farmers in these areas actually are not less receptive to new technologies

2.5.2 Dry season cultivation remains far below the potential made possible by the irrigation system. Figure 2.5.2 shows the variation in cultivated area over the period 1980/81 through 1985/86. The large drop in cultivated area in 1981/82 was due to the reduction in the amount of rice grown in the dry season. Not counting dry season rice, groundnuts have been the principal dry season crop for at least the past seven years, but, as shown in Table 3 (b) of Attachment C, the area under

cultivation fluctuates considerably from year to year. This is due in part to high prices in one year, followed by over-production and low prices the following year. These low prices then depress production in the third year. It is also due in part, as is noted in Section 6, to improperly handled government intervention in the local groundnut market, which has tended to raise prices artificially high during periods of low production, with no provisions for sustaining prices during periods of high production.

Other dry season crops grown in the LNO area are watermelons, pumpkins, sweetcorn, young-ear corn, tomatoes, chillies and vegetables. However, as Table (b) of Attachment C shows, the area under cultivation and the production volume have tended to be low. Crops for supply to agro-processors appear to have a good potential at LNO, but while some agro-business firms have investigated the area and some have begun production of crops, volumes are low.

2.5.3 The LNO irrigation system has made a major contribution to agriculture in the area. Prior to the introduction of irrigation, farmers frequently had major rice crop failures due to droughts or floods. They are now virtually assured of a successful wet season rice harvest with production per rai at two to three times the pre-irrigation levels. Without the irrigation system there would be no dry season agriculture of any significance.

2.5.4 The primary factors other than water availability which limit agricultural production in the LNO area are, in rough order of priority:

a. Wet Season

- inadequate fertilizer usage
- need for improved rice strains
- pests

b. Dry Season

- lack of markets or marketing channels
- poor prices
- soil salinity
- lack of technical knowledge of crops with demonstrated market
- shortage of labor (family level)

OAE reports from 1980/81, consultant reports and interviews with farmers in the LNO area consistently point to the lack of markets or weak market linkages as one of the major problems limiting dry season agricultural production. Poor prices and hence a lack of sufficient inducement to plant is also a problem. However, this is also in part related to the quality of crops produced in the area. In the case of groundnuts it is clear that LNO farmers are producing fairly good quality crops, but the variety (suitable for oil extraction) is not in high demand and commands a lower price than other varieties. Other agro-industrial crops such as tomatoes produced up to the present time have been of generally poor quality, and much of the crop has been unsuitable for processing. Current pre-production tests now underway at LNO are devoting a great deal of effort to quality control, but at present their production volume is low.

Soil salinity is a problem endemic throughout the LNO area, and while it is noted as a problem in interviews, it is evident that there is a large amount of land at LNO which is suitable for dry season cropping but which is not used.

A shortage of labor is also frequently noted in reports and interviews. However, this is a shortage at the family level. The 1985 OAE evaluation of the LNO project noted that between 1980/81 and 1984/85 the average area cultivated per family dropped from 4.85 rai to 2.55 rai due to inadequate labor in the family. In part, this may be due to a shift from dry season rice to field crops which are more labor intensive. Nevertheless, there are many farm families at LNO which do not cultivate in the dry season, so on a project wide basis it does not appear that a shortage of labor is an obstacle to increased production.

2.6 Evaluation of the Microcomputer-Based Water Management System

2.6.1 The microcomputer based water management system used at Lam Nam Oon was initiated by the resident irrigation engineer of the consulting firm. During the period when the system was being developed, the engineer used his own computer and did the basic programming for the system. A counterpart was assigned to work with the engineer during this period. Aside from the salary and incidental costs for this official, there were no costs associated with his training. At the completion of the term of service of the expatriate engineer,

he sold the computer to the Project Field Director, who permitted its continued use for developing the water management system. Later, a second eight bit Epson computer and dot matrix printer were purchased by the RID for use at LNO at a cost below 100,000 baht. Two computer technicians were assigned to the project, while the original computer technician took a leave of absence to pursue a degree at Kasetsart University. He is expected to return to LNO in late 1986 on completion of his studies. In the meantime, he visits the project regularly.

2.6.2 The Deputy Chief of O&M at LNO received a scholarship in 1985 from Utah State University for a course of study on water management. This official paid for his own round-trip transportation to the United States. There was no cost to RID, except having to forego the services of this official for one year. While at Utah State he developed a computer based water management model for the Lam Nam Oon project covering both the LMC and RMC. As noted elsewhere in this report, this revision of the first model will be implemented with assistance from a team from the USAID supported Water Management Synthesis Project. In conjunction with this assistance, a Hewlett-Packard 16-bit microcomputer will be provided to the LNO O&M section under USAID support to the Nam Pong project in Khonkaen.

Thus, training costs for personnel to operate the computer-based water management system have been virtually non-existent up to the present time. While the new water management

system has not yet been implemented, RID O&M personnel continue to gain experience in water management through use of the original system.

2.6.3 Determining the relative utility of the computer based water management system to other non-computer managed irrigation systems in the Northeast demands consideration of several factors, including the size of the projects, their terrain, the types of crops anticipated for each project and whether the projects are intended to provide only supplementary irrigation during the rainy season or also to provide water for dry season cultivation. Small-scale projects and projects intended only for supplementary irrigation are less complicated and managers ought to be able to monitor conditions and water requirements without the assistance of a computer.

The LNO irrigation system is quite complex and when widespread dry season cultivation is achieved, managers will have to make frequent decisions which affect only small parts of the irrigation system. This will require them to be able to access information on these areas quickly and to be able to evaluate the impact of a decision for one area on other areas. For example, it is expected that in the future a variety of crops with different water requirements and different maturation periods will be grown in the same general area. Keeping track of all of this information by manual means would be cumbersome and prone to error. Thus, while the computer based water management system is

not essential now, when the intensity of dry season cultivation is low, it will be quite valuable in the future.

2.6.4 Other uses of the LNO computer facilities.

In addition to water management, the computers are now being used by officials of the Provincial Land Consolidation Office in their land titling program. About twenty-five percent of the names and pertinent information of those participating in the land consolidation program have already been incorporated in the data base. This will facilitate the granting of land titles, and might be of use in future monitoring agricultural production.

The DOA representative at LNO is preparing to use the computer to analyze the results of field trials being conducted on dry season crops in the project area. Also, with the arrival of the new Hewlett-Packard computer in June 1986, one of the two existing machines will be used to manage office affairs and correspondence. Other possible uses of the computers are monitoring the use of maintenance equipment and materials. After a few years of such monitoring, LNO O&M staff will be able to forecast maintenance costs realistically, instead of being dependent on the present formula allocation of maintenance budgets.

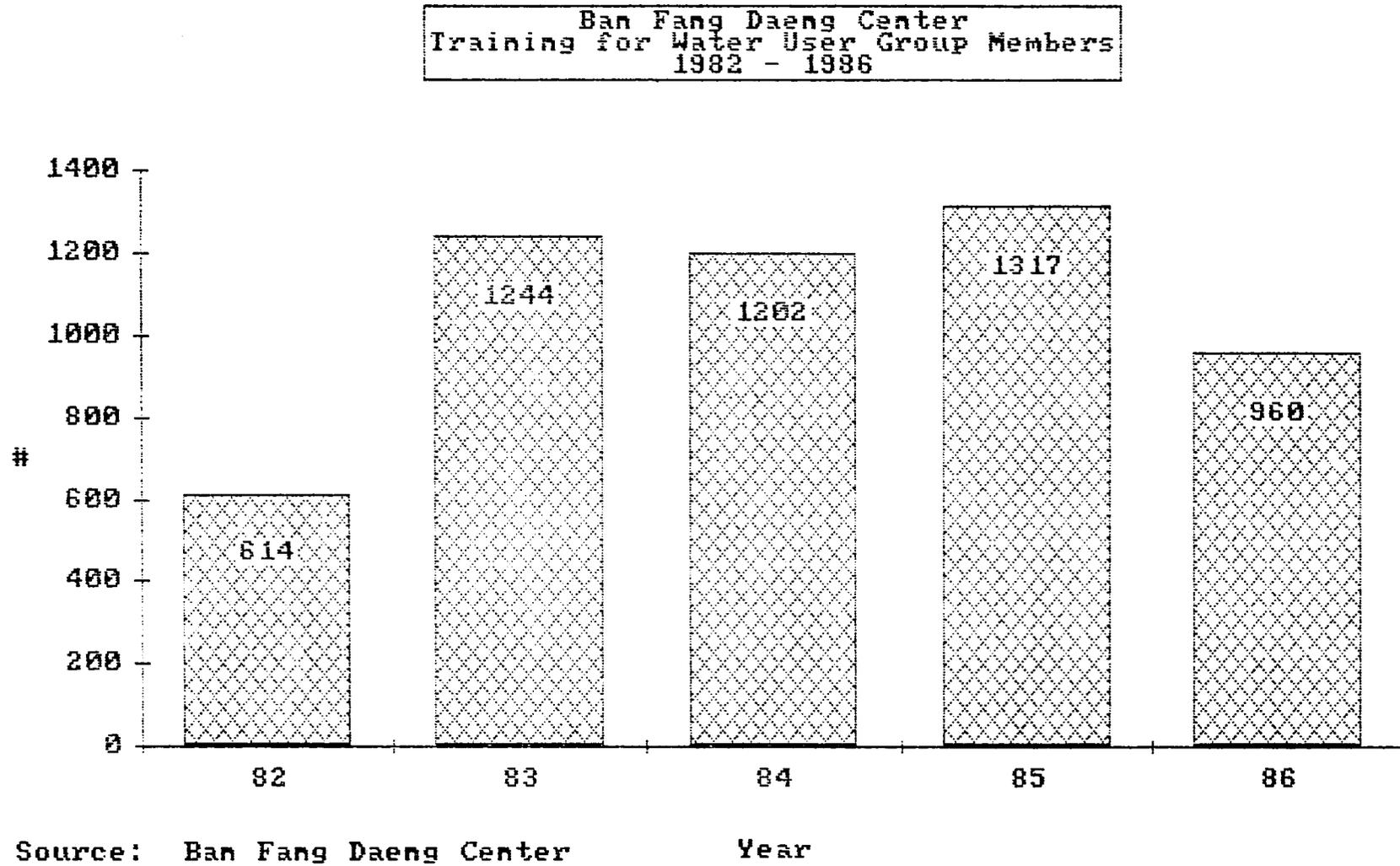
2.7 Assessment of the Quality and Relevance of Project Funded Training and Extension Efforts.

2.7.1 Training and extension activities supported by USAID funding involved five agencies: RID, CDD, DOAE, DOF,

and NFE. The extension program of DOAE appears to have focused on field crops with little specific attention to irrigated agriculture. A review of the training program for amphur and tambon agriculture officials of the Sakon Nakorn Agriculture Office shows no specific reference to irrigated agriculture. It was not possible to observe the activities of tambon agricultural workers in the LNO area, but interviews with farmers suggested that these workers did not address themselves to issues involving irrigated agriculture. The DOF has a consistent record of relevant and high quality extension work, close contact with farmers who raise or plan to raise fish, and an interest in what others are doing in the LNO area. For example, fisheries officers are aware of the effort to promote agro-industrial crops such as tomatoes and seeds and support these efforts, but expressed a need for some coordination with their own programs because of the dangers of pesticide and chemical contamination of fishponds in the area. Also, DOF officials can regularly be found visiting farmers on the weekend.

2.7.2 The Ban Fang Daeng Integrated Rural Development Center is an essential component of the overall LNO project. Senior RID officials credit the center for the success in establishing functioning water user groups in contrast to the poor record at many other projects in the Northeast. The heads and many members of water user groups have been trained at the center.

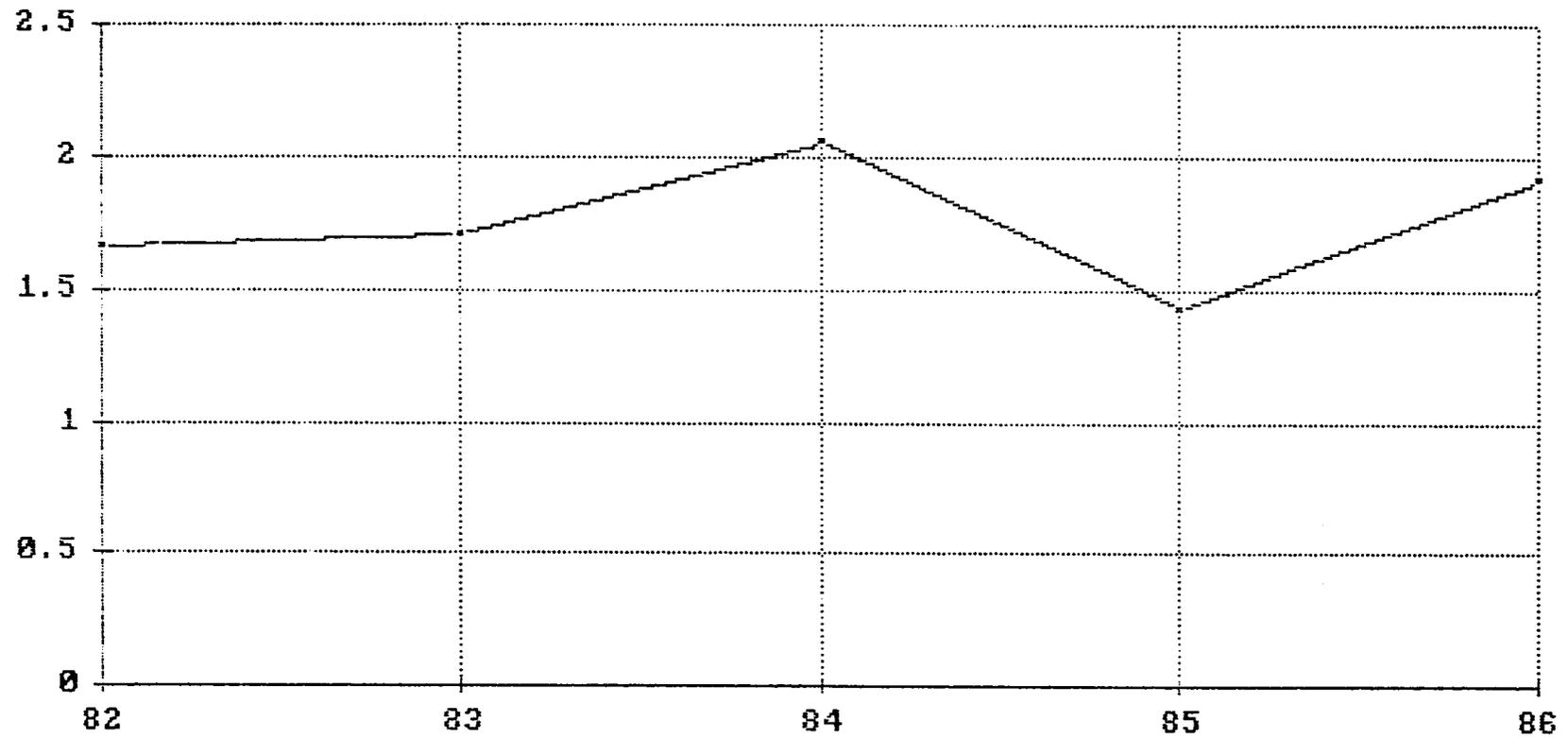
Figure 2.7.2 (a)



4/6

Figure 2.7.2 (b)

Ban Fang Daeng Center
Annual Budget - 1982/86
(Million Baht)



Source: Ban Fang Daeng Center

Year

Originally, the training program lasted five days, but later was reduced to three days to retain the interest of the participants. The curriculum for this training was determined by the LNO working group and consists of a basic introduction to all facets of the project.

Training Program for Water User Groups

- Day 1: - Overview of the LNO Irrigation System
 - On-Farm Water Distribution
 - Water User Group Management

- Day 2: - Principles of Mixed Farming
 - Rice Cultivation Under Irrigated Conditions
 - Fish Farming
 - Cultivation of Field Crops, Vegetable and Fruit Crops Under Irrigated Conditions

- Day 3: - Introduction to Cooperatives
 - Marketing and Farm Management
 - Field Trip

In every year except 1983 the center also conducted separate two day seminars for heads of water user groups. About 120 persons attended these seminars each year. In addition to the training of water user groups, the center provides identical training to women's and youth groups, thus broadening the base of understanding of irrigated agriculture and preparing the next generation of irrigators.

Other government agencies regularly use the facilities at Ban Fang Daeng for their own training programs, for seminars or for observation tours. The District Health Office in Phang Khone was said to use the center frequently. Other irrigation projects in the Northeast, such as Nong Wai, have sent

officials to observe the operations and activities of the center, and the CDD workers in the thirteen tambons in the LNO area meet monthly at the center. These workers have been instructed by the governor of Sakon Nakorn to work closely with the water user groups. The previous director of the center has given lectures in CDD training programs elsewhere in the country and at secondary schools in the project area on subjects related to irrigated agriculture.

Judging from interviews with many water user group members who had completed one or more training programs at Ban Fang Daeng, these farmers had a firm grasp of how the irrigation system functioned, what their obligations as members of water user groups were, and moreover, were able to articulate this information clearly.

2.7.3 The CDD took a rare step for a government agency in permitting what had been planned as a normal Saraphi training center to be transformed into an integrated rural development center to serve in particular the needs of the LNO project. The CDD also established a special fund to support CDD activities in each of the thirteen tambons within the project boundaries. USAID funding for facilities at the center encouraged CDD in taking this step. However, the commitment of the CDD to the present orientation and programs of the center has persisted beyond the termination of USAID involvement. A meeting of CDD policy makers was held in the latter part of January 1986 to consider ways to maintain the current Ban Fang Daeng program

even though the center will be reintegrated into the regular CDD program. It seems that for the purpose of annual budgeting the center will have to be included under the Saraphi center budget item which involves certain stipulations for the types of activity to be carried out in such centers.

2.8 Summary of Findings and Recommendations

Over the course of the LNO Integrated Rural Development Project considerable progress has been made in operating and maintaining the irrigation system, in involving the farmers of the area in maintaining the on-farm water distribution and drainage network through well-functioning water user groups, in raising the level of rice production during the rainy season to two to three times the level before irrigation was available, and in developing individual and communal fish ponds for subsistence purposes. Dry season cultivation has not progressed satisfactorily, largely due to the lack of linkages between the farmers and market outlets. Over the five years of the project a well-defined marketing strategy has evolved which is focused on involving private sector agribusiness firms in the production, processing and marketing of dry season crops. This strategy began to be implemented in 1985 with the full support of RID and has already resulted in four firms initiating crop production programs in the area, in the development of market linkages with a local canning factory with the involvement of a major multinational food processor. The principal findings and recommendations are presented in the following matrix.

<u>FINDINGS</u>	<u>RECOMMENDATIONS</u>	<u>AGENCIES</u>	<u>FINDINGS</u>	<u>RECOMMENDATIONS</u>	<u>AGENCIES</u>
1. THE IRRIGATION SYSTEM IS ABLE TO PROVIDE WATER TO 167,000 RAI IN THE DRY SEASON & 67,000 RAI IN DRY SEASON. THERE IS 100% CULTIVATION IN THE WET SEASON AND 13% OR LESS IN THE DRY SEASON.	GREATER EMPHASIS NEEDS TO BE GIVEN TO DRY SEASON CROPPING. MOST IMPORTANT IS MARKET DEVELOPMENT, BUT RTG TECHNICAL SUPPORT IN DEVELOPING NEW CROPS, TECHNIQUES & EXTENSION SERVICES FOR IRRIGATED AGRICULTURE NEEDS TO BE INCREASED.	DOA DOAE RID	6. VARIOUS AGRO-BUSINESS FIRMS ARE UNDERTAKING OR ARE CONSIDERING PRODUCTION/PROCESSING ACTIVITIES AT LNO. BAAC LENDING PRACTICES THROUGHOUT THE COUNTRY ARE TENDING TOWARD INDIVIDUAL BORROWERS RATHER THAN COOPERATIVES OR FARMERS' GROUPS. INSTANCES OF BAAC REFUSAL TO MAKE LOANS TO FARMERS IN THE LNO AREA DUE TO NON-CONFORMITY WITH BAAC CRITERIA/POLICY WERE NOTED. IF THIS IS WIDE-SPREAD, IT MAY BE AN OBSTACLE TO AGRO-INDUSTRIAL PRODUCTION WHICH HAS A HIGH LEVEL OF INPUTS WHICH REQUIRE CREDIT.	SUCH INVESTMENT SHOULD BE ENCOURAGED BY THE RTG. BOI PRIVILEGES SHOULD BE PROVIDED FOR INVESTORS AT LNO AND OTHER LARGE IRRIGATION PROJECTS. ASSISTANCE TO FARMERS AND AGRO-BUSINESSES BY THE SPECIFIC ASSIGNMENT TEAM SHOULD BE CONTINUED. LNO PROJECT MANAGEMENT SHOULD HAVE A ROLE IN APPROVING INVESTORS AT LNO TO INSURE GENERAL CONFORMITY WITH PROJECT CAPABILITIES AND MANAGEMENT REQUIREMENTS. LNO SHOULD HAVE A PERMANENT MARKETING PROGRAM TO ASSIST IN MAKING LINKAGES WITH THE PRIVATE SECTOR. THERE IS A NEED FOR PROGRAMS TO TRANSFER NEW TECHNOLOGY TO FARMERS WHICH IS REQUIRED FOR INDUSTRIAL CROP PRODUCTION. LNO SHOULD CLARIFY BAAC ABILITY/INCLINATION/NEED TO SUPPORT THE LNO DRY SEASON CROPPING PROGRAM. THEN LNO SHOULD REACH AGREEMENTS OR UNDERSTANDINGS ON BAAC PARTICIPATION.	MOI BOI NESDB JPPOC MOC MOC MSTE BAAC
2. THE TERMS OF PIL NO. 14 WERE SUBSTANTIALLY MET. HOWEVER, AGRICULTURAL RESEARCH & EXTENSION ACTIVITIES REMAIN INADEQUATE.	INCREASED EMPHASIS SHOULD BE GIVEN TO RESEARCH & EXTENSION SPECIFICALLY FOCUSED ON IRRIGATED AGRICULTURE IN THE DRY SEASON. PARTICULAR ATTENTION SHOULD BE FOCUSED ON CROPS SUITABLE FOR AGRO-PROCESSING. DEVELOPMENT AND MANAGEMENT OF FISHERIES ACTIVITIES IN THE RESERVOIR SHOULD BE UNDERTAKEN, TOGETHER WITH PROMOTION OF COMMERCIAL FISHERIES ACTIVITIES IN PRIVATE & COMMUNAL PONDS.	DOA DOAE DOF			
3. ABOVE-FARM O&M HAS IMPROVED AND BECOME MORE SYSTEMATIC. PHYSICAL FACILITIES ARE IN GENERALLY GOOD CONDITION. MOST WATER USER GROUPS WORK WELL, BUT WILL NEED ADDITIONAL EXPERTISE AS CULTIVATED AREA INCREASES AND NEW CROPS ARE INTRODUCED.	REALISTIC, RATHER THAN OPTIMAL, MAINTENANCE LEVEL SHOULD BE DETERMINED AND COMPARED TO ACTUAL MAINTENANCE EXPENDITURES. ONGOING TRAINING FOR WATER USER GROUPS AND SECOND GENERATION IRRIGATORS IS REQUIRED. THE BAN FANG DAENG TRAINING CENTER SHOULD CONTINUE TO PROVIDE SUPPORT TO WATER USER GROUPS, BUT SHOULD EXPAND TRAINING IN SUBJECTS RELATED TO IRRIGATED AGRICULTURE FOR WOMEN'S AND YOUTH GROUPS.	RID CDD MOE			
4. A COMPUTERIZED WATER MANAGEMENT SYSTEM HAS BEEN DEVELOPED AND WILL BE TESTED BEGINNING IN JUNE 1986.	THE INTRODUCTION OF THE SYSTEM WILL REQUIRE SUSTAINED ATTENTION OVER SEVERAL YEARS. RID SHOULD INSURE THE PRESENCE OF EXPERIENCED STAFF AND MINIMIZE STAFF ROTATION DURING THE INITIAL PERIOD.	RID		LNO SHOULD WORK CLOSELY WITH THE SAKON NAKHORN PROVINCIAL ADMINISTRATION, PARTICULARLY THE GOVERNOR. WAYS SHOULD BE EXPLORED TO PERMIT THE LNO FIELD DIRECTOR TO PARTICIPATE ON THE PROVINCIAL PLANNING COMMITTEE.	
5. A CORE GROUP OF RTG AGENCIES CONTINUE CLOSE COOPERATION AT LNO. OTHERS HAVE REVERTED TO EARLIER FORM - I.E PARENT AGENCY ORIENTATION ONLY	LARGE IRRIGATION PROJECTS, SUCH AS LNO, SHOULD BE GIVEN A SPECIAL STATUS SIMILAR TO THAT OF "POVERTY AREAS" SO THAT RTG AGENCIES MUST TAKE LNO CONDITIONS INTO ACCOUNT WHEN PREPARING ANNUAL BUDGET REQUESTS.	NESDB RID MOAC MINT MOE MOI CDD	7. RID HAS DEVELOPED A MORE COMPREHENSIVE PERSPECTIVE TOWARDS IRRIGATION PROJECTS & WILL TAKE THE INITIATIVE IN COORDINATING NECESSARY INPUTS.	THE NATIONAL IRRIGATED AGRICULTURE COMMITTEE SHOULD GIVE ACTIVE SUPPORT TO RID PLANS TO SET UP A UNIT TO SUPERVISE THE FOUR MODEL IRRIGATION PROJECTS WHICH IT IS NOW IDENTIFYING.	MOAC RID MINT NESDB

MATRIX OF FINDINGS, RECOMMENDATIONS AND CONCERNED AGENCIES

3.0 Review of Social Conditions in Lam Nam Oon Area

3.1 The Lam Nam Oon Project area covers an irrigated area of approximately 183,000 rai located in 3 districts of Sakon Nakhon Province. The main objectives of the project were to solve flooding problems in Amphoe Phang Khon, Phanna Nikhom and Muang Sakon Nakhon, to stabilize and increase wet season rice production and to provide water for dry season cultivation. The construction of the dam started in 1967 and lasted until 1973. The distribution of water and land consolidation activities started subsequently. It is expected that land consolidation activities will be completed in 1986.

The people of the Lam Nam Oon area consist mostly of Northeastern Thai and/or Lao, speaking either Mon-Khmer or Tai-Kadai languages. They migrated from North Laos and South Tonkin areas. Although they may be ethnically distinct, they are not very different and may be said to have been descended from related stock. Physical appearances of all ethnic groups in the area are similar and they have been living in adjacent areas with no difficulty. However there is no evidence from past incidents to indicate that the combination of different but related ethnic groups living in the same general location had become a constraint to development.

It is the policy of the Thai Government to promote assimilation and/or integration among the various ethnic groups living in the different parts of the country, especially if the

people are culturally similar to the Thais. Among officials and local residents, one often hears stereotyped characterizations of other ethnic groups, for example that the Phuthai are diligent and hard working, while the So are lazy, and the Noar have strong leadership. Officials did not appear to have any particular problem in dealing with one ethnic group over another. However, officials who dealt with local residents on a daily basis seemed to be more sensitive to ethnic differences than did those who were not in regular contact.

Ethnic Groups Identified in the LNO Project Area

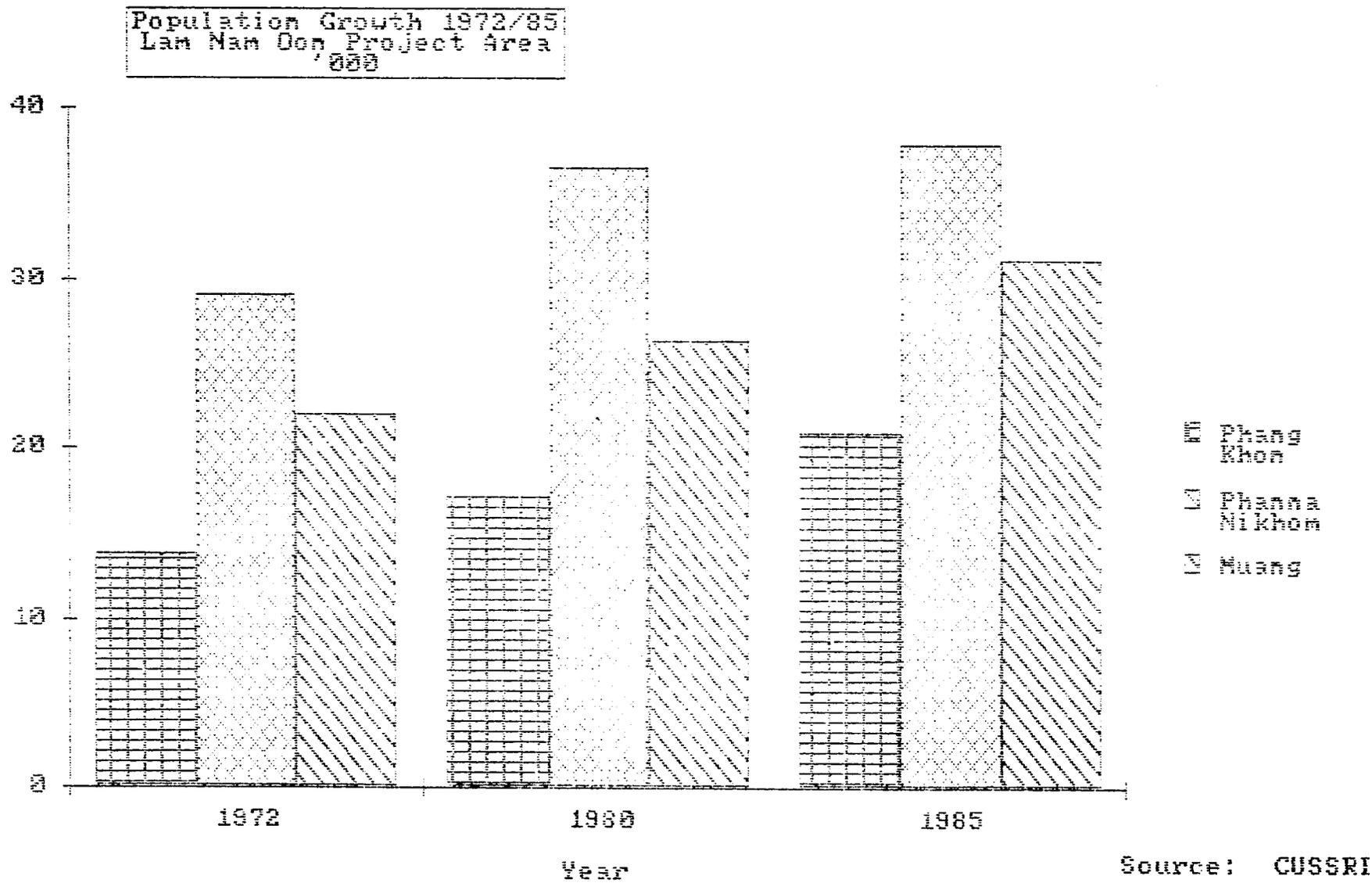
Ethnic Group	Original Location	Linguistic Group	Religion	Approximate Number	Economy
Oy*	Laos	Mon-Khmer	Kalam Buddhist	4500 (in 1932)	Wet Rice
Noar	Loas-Vietnam border	Mon-Khmer	-		
So	Both sides of Mekong	Mon-Khmer	Theravada Buddhist and Cult of Ancestors	?	Wet Rice
Phuthai	NE Laos (Sip Song Chao Thai)	Tai	Animist Buddhist	70,000/ 100,000	Wet Rice
Laos	Laos	Tai	Buddhist	?	Wet Rice

Source: Le Bar, Frank M., et al. Ethnic Groups of Mainland Southeast Asia, New Haven: Human Relations Area Files Press, 1964

3.2 Population - LNO Area

The population of the LNO area has grown steadily over the period 1972-1985. However, as shown in the following table, both Phang Khon and Muang Districts maintained high annual growth rates throughout the period, while Phanna Nikhom District

Figure 3.2



experienced a dramatic drop in its growth rate from 3.2% for the period 1972-1980 to 0.5% for the period 1980-1985. While overpopulation in the LNO area is not expected to be a serious problem for some time, it is likely that underemployment in the agricultural sector will reach serious proportions in the near future. The future labor absorptive capacity of the crop subsector is quite low, if traditional agricultural practices are continued. Furthermore, alternative employment opportunities in the urban areas and overseas are declining.

Percent Annual Population Change in the Lam Nam Don
Project Area 1972-1985

District/ Tambon (T)	Area km ² (1)	Population			% Annual Change	
		1972 (2)	1980 (3)	1985 (4)	1972-1980 (5)	1980-1985 (6)
Phang Khon District						
T. Hi Yong	31.84	7,321	8,977	8,815	2.8	-0.4
T. Rae	19.20	2,371	3,827	5,741	7.7	10.0
T. Phang Khon	7.68	2,033	2,167	-	0.8	-
T. Ton Phueng	23.20	2,218	4,313	6,328	11.8	9.3
Total Phang Khon	81.92	13,943	17,177	20,884	4.8	4.4
Phanna Nikhom						
T. Chang Ming	25.44	5,729	7,071	7,548	2.9	1.3
T. Phanna	23.04	6,472	6,887	7,858	0.8	2.8
T. Rai	18.72	2,800	3,799	3,966	4.5	0.9
T. Wang Yang	38.56	4,850	6,067	5,126	3.1	-1.5
T. Na Hua Bo	17.28	4,446	6,787	5,196	6.6	-4.7
T. Phok Noi	25.76	4,753	5,933	7,697	3.1	5.9
Total Phanna Nikhom	148.80	29,050	36,544	37,891	3.2	0.5
Muang District						
T. Muamin	39.68	-	12,541	13,865	-	2.1
T. Chieng Khrua	4.00	-	1,857	4,144	-	24.6
T. Phang Kwang	10.40	-	4,089	3,450	-	-3.1
T. That Na Weng	40.00	-	7,779	9,665	-	4.8
Total Muang	94.08	-	26,266	31,124	-	3.7

Source : (1) (2) (3) Sutthichit Chintayanon, 1983.
(4) Lam Nam Don Project, Ban Fang Daeng Training
Center, 1986

The land holding pattern in the LNO Area does not differ much from that in other parts of the Northeast. The OAE report on LNO for the 1984/85 crop year gave the average land holding size to be 21.40 rai per household with only 5% of the farmers renting land for cultivation (OAE, 1986).

The land in the LNO area is generally poor. In fact, much of the land is so saline that many local residents actually extract salt from it for home consumption, and perhaps local sale. As a result of the land consolidation program and the construction of the irrigation system, estimated land values have generally increased. Despite this increase (which in many cases is clearly due to over-evaluation by government officials), there does not appear to be any tendency on the part of residents to sell their land. In fact, most of the farmers interviewed could not recall any land sales in their area over past five years or so. The low level of land transactions is also reflected in the records of the Land Consolidation Office. Between 1980 and 1985 only 1.24% of the land at LNO changed hands (see following table).

Land Transactions in LNO Project Area, 1980-1985

Type of Land	Cases	Plots
a. paddy area	313	330
homestead area	118	170
irrigation infrastructure	20	20
permission not granted	30	30
total	431	500
b. individual private transactions	263	280
single buyer	5	10
Total area transacted	1,747	rai
Total land consolidated	140,979	rai
% area transacted	1.24	%

Household Income. Household income in the LNO area by source is shown in the following table.

Average Cash Income per Household

	Intensive		Extensive		Wildflood		Total	
	Rai	%	Rai	%	Rai	%	Rai	%
Cultivation Within								
Project Area	3,375.13	60.21	2,847.35	47.82	1,823.83	40.39	2,780.58	48.09
Cultivation Outside	270.73	4.83	201.66	3.39	52.56	1.17	191.36	3.31
Poultry	43.45	.78	139.98	2.35	392.57	8.69	158.89	2.75
Cattle	1,907.27	34.02	2,646.17	44.44	2,233.84	49.47	2,550.51	41.12
Fish	9.09	.16	119.11	2.00	12.82	.28	100.26	1.73
Total	5,605.67	100.0	5,954.27	100.0	4,515.62	100.0	5,781.68	100.0

Source : OAE, 1986.

It can be seen that those residents who farm in areas covered by the on-farm distribution system earn substantially more from crop cultivation than those in undeveloped (wildflood) areas, as well as earning greater income overall. It is interesting to note that farmers in intensive areas earn much less income from activities other than cultivation than do farmers in both of the other two types of area. This probably results from their land being more suitable for agriculture following the intensive on-farm construction. As shown in the table below farmers in the intensive area have 96.51% of their land classified as cultivatable, versus 86.58% for farmers in extensive areas and 83.92% for farmers in wildflood areas. Farmers in intensive areas also have only .42% of their land classified as vacant, in contrast to 6.31% for those in extensive areas and 13.45% for those in wildflood areas.

Average Land Use Pattern per Household

	Intensive		Extensive		Wildflood		Total	
	Rai	%	Rai	%	Rai	%	Rai	%
House Compound	.20	1.06	.29	1.36	.17	.73	.27	1.26
Cultivable Area	18.23	96.51	18.51	86.58	19.47	83.92	18.60	86.92
Fish Pond	.17	.90	.23	1.08	.11	.48	.22	1.03
Vacant Land	.08	.42	1.35	6.31	3.12	13.45	1.44	6.73
Other	.21	1.11	1.00	4.67	.33	1.42	.87	4.06
Total	18.89	100	21.38	100	23.20	100	21.40	100
Number of farmers who raise fish		16.36		21.02		7.69		19.32

Source: OAE, 1986

Overall cash income for farmers in the extensive areas is also higher than in either of the other areas, and these farmers earn more from cattle and fish raising. This suggests that having greater flexibility in their economic activity may contribute to increased earnings.

The team was not able to evaluate the extent of off-farm or non-farm income for residents of the LNO area. This has traditionally been a significant source of income for Northeastern farmers, accounting for 25% to 50% of total rural household income. Much of this income tends to be in kind, rather than in cash. While some of this income is generated by the production of traditional handicrafts (mats, baskets and cloth), there was also evidence of rather large putting-out schemes in the area. One such scheme employed a large, but undetermined, number of people in the LNO area in the production of bamboo baskets for export to Japan for use in growing seaweed.

In those areas where access to water was previously limited, wet season rice production is two to three times greater than before. Even lowland areas, some of which previously used traditional fai (dams) for supplementary irrigation in the wet season, obtained at least the same level of wet season rice production as before, but were now able to plant in the dry season as well. This increase in agricultural productivity may account in part for the low volume of land transfers. However, it must be kept in mind that the volume of land transactions in the Northeast has always been relatively low, especially when compared to the Central Region.

In the next 20 years, if the volume of land transactions remains at this rate, it will be an indication that LNO development project has reached the poor and remained with the poor. Attempts should be made to keep land speculators and money lenders from obtaining land rights in the project area.

3.3 The Social Organization of the Water User Groups and the Training Programs for Water User Groups

In most irrigation projects, the water user groups are one of the more important factors required for successful operation and maintenance. The need for the organization of water user groups was a relatively new concept to most LNO farmers. However the idea of group organization is not foreign to local residents. There are a variety of community organizational patterns indigenous to the area, including several community irrigation systems.

The following table indicates the number of WUGs and the O&M activities for dry season 1985/1986. Figures were obtained from several sources and are contradictory in a few places. At any rate, the latest total figure for water user groups is 611. A few groups have not been organized in Muang District because they are in areas where construction and land consolidation activities have recently been completed. On-farm construction remains to be done on about 2000 rai of land in Muang District. Following completion of this work, the remaining water user groups will be organized and trained at the Ban Fang Daeng Center.

The Specific Assignment Team helped in organizing the water user groups especially during the initial meetings when the chairmen of the groups were elected and regulations were adopted by water user group members. These regulations include the rate of fines (ranging from 30 to 50 baht) to be collected when members fail to join in the operation and maintenance activities on the agreed upon date.

A sample of 19 water user groups were interviewed in depth over a two day period. While all of these groups were found to be functioning adequately, a number of problems were found to affect the operations of some of these groups. These problems were the tendency of headenders (those nearest the turnout gates to the on-farm ditches) to divert excessive amounts of water to their fields, thus depriving some of those toward the end of the ditches of the water they needed for cultivation. In

some cases this problem stemmed from anxiety over water deliveries, but in other cases resulted from a conscious attempt on the part of headenders to take advantage of their position on the ditch, regardless of the effect of their actions on other farmers.

In a few instances water user groups imposed sanctions on members who did not fulfill their obligations to perform maintenance. Several examples were found where fines were levied. In one case, a member failed to help with on-farm maintenance and also refused to pay the required fine. As a result, the chairman of the group decided to give water to all other members of the group first.

Water user groups in Muang District are reported to be more difficult to organize because of the late date of completion of the project. Also farmers in Muang District tend to be more urbanized. Many of them rent out land and therefore are not interested in joining the water user groups. Land renters are also not very cooperative because they do not belong to the community on a permanent arrangement. This parallels the experience of irrigation projects in the Central Region where the number of absentee landlords and percentage of land renters are high, cooperation among farmers in the water user groups are also very difficult to obtain.

Water User Groups and O & M Activities for Dry Season
1985/1986

O	Unit	Area in rai	No. of villages	No. of WUG	No. of Groups Doing Maintenance 1985/86
	1	10,535	6	*28(27)	28
	2	6,800	5	29	29
	3	8,470	7	26	24
	4	20,500	9	76	73
	5	4,700	2	(18)	
	6	11,400	10	(39)	
	7	8550	9	21	9
	8	12,000	6	(28)	
	9	13,400	7	45	35
	10	18,900	10	41(42)	41
	11	7,100	4	9(16)	9
	12	5,500	3	9	9
	13	10,900	4	12	12
	14	11,130	4	35	35
	15	7,100	5	19(18)	19
	16	11,700	8	40	40
	17	3,875	4	15	15
	18	9,700	3	14(18)	14
	19	6,900	6	(29)	5
	20	6,200	3	5	(45)
	21	12,375	5	(19)	(35)
	22	17,400	6	(60)	(18)
	23	5,380	3	(35)	(35)
	Total	230,515			397

- Source :
- (1) LNO Project, Summary of O & M Activities of WUG in Land Consolidation Area, 1986
 - (2) LNO Project, The Establishment of WUG 1980-1985
 - (3) LNO Project, Ban Fang Daeng Training Center, Population Data, 1986.
 - (*) number in () are from (2) when no information is available in (1) or when (2) does not agree with (1)

From interviews with farmers, SAT members and zonemen, problems related to water user groups may be itemized as follows:

- a. Individuals whose fields are at higher elevation and did not receive water regularly tend to be neglecting the duty to cooperate.

- b. Individuals may not attend their fields at the specified schedules for water delivery, especially when there are good television entertainment programs. Many individuals then request for rescheduling.
- c. Many individuals have their fields and their homesteads in separate location. Meetings are difficult to call because members live in different villages.
- d. Individuals who sometimes do not cooperate include:
 - Those whose fields are upstream.
 - Those who are relatively rich.
 - Those who are very poor and cannot donate or pay for labor.
 - Those who rent land for cultivation

The 1974 Land Consolidation Act stated the duty of the Land Consolidation Office (LCO) to collect part of the construction and operation and maintenance cost from the farmers benefitting from the water from irrigation systems. The LCO may collect the money from the farmers directly, through water user groups, or even through cooperatives, if water user cooperatives were to be established. However, the 1974 Act did not require that the LCO set up water user cooperatives. On the other hand, the Department of Cooperative Promotion would like to promote water user cooperatives in irrigation areas.

At present the water user groups at LNO seem to be operating reasonably well and there is no reason to make the water user groups into cooperatives. The Lam Nam Oon staff feel that for the present time it is better to treat cooperatives and water user groups as two separate issues. Farmers living in the

LNO project area have to join the water user groups where their irrigated land are located. However, while these differ from cooperatives both in terms of their legal status and purpose, these groups are helping to instill many of the principles which will permit their members to participate effectively in existing or yet to be established cooperatives in the LNO area.

It was reported that the water user cooperative at the Nong Wai Irrigation Project was functioning effectively. Although this could not be confirmed through a site visit, it suggests that such a cooperative may eventually be able to play a role at LNO. However, it should be kept in mind that the organizational requirements of a cooperative are substantial, so the benefits to be derived from the cooperative should be commensurate with the efforts put into its establishment and support. It appears that if the principal function of a cooperative at LNO is to merely collect user fees from farmers, rather than to engage in any other economic activity, the organizational costs will far outweigh the benefits.

Successful water user groups and the future of the local organizations within the land consolidation area depend very much on the training programs available. The training center at Ban Wang Daeng has been functioning well in providing information to the chairmen and members of the water user groups. The miniature irrigation system at the center provides a realistic situation for the training. The farmers who have gone through a training program certainly acquire a great deal of

new information. Furthermore, the training programs for the water user groups have proven to be very effective. All of the farmers interviewed agreed that they have benefitted from the training. A few farmers (the chairmen of the water user groups) had participated in water user group training programs for three consecutive years. Other chairmen allowed members of the water user groups to attend the training in their places.

Training classes at Ban Fang Daeng, 1982-1986.

	1982		1983		1984		1985		1986	
	Class Number		Class Number		Class Number		Class Number		Class Number	
Water User Groups	11	614	26	1,244	30	1,202	30	1,317	24	960
Youth	2	128	2	125	--	-----	--	-----	2	120
Women	1	80	2	118	--	-----	--	-----	2	120
Chairman of WUG	2	60	-	-	2	120	2	120	2	120
Other Gov't training	5	224	11	627	17	1,037	23	1,194	11	350
Budget (RTG) Baht	1,656,831		1,710,680		2,045,180		1,425,660		150,000	

A major portion of the leadership of the water user groups has received training at the Ban Fang Daeng Center. The remaining members should also be trained in the basic elements of the irrigation system and irrigated agriculture. Perhaps more important to the long term development of the LNO area is the training of the youth who are not yet farmers. As seen in the above table, the training of youth in irrigated agriculture is still a relatively minor program of the Ban Fan Daeng center.

3.4 Specific Assignment Teams

Over the past five years, LNO has employed a group of young men and women to support the efforts of government officials to achieve certain high priority objectives of the

project. This group, called the Specific Assignment Team (SAT), has 28 members. Qualifications for employment with the SAT are an agriculture vocational training at grade 12 or grade 13 level. The SAT members are hired on a temporary basis by the RID using funds budgeted for construction activities. Each member of SAT receives a wage of 84 baht/day with overtime and living accommodations provided them by the project. SAT members are closely supervised and attend weekly meetings where they review their performance and identify issues which need to be followed up. Maintaining good relations between SAT members and the farmers is essential to the success of the SAT program, so members are reminded that conflicts with farmers will constitute grounds for dismissal.

Among the general on-farm support activities performed by the SAT are:

- a. helping to set up water user groups
- b. serving as a link between farmers and RID officers
- c. helping to identify solutions to problems in their early stages
- d. promoting development activities among the water user groups.

There are two types of Specific Action Team (SAT) operating at LNO. The first type is location specific. It is responsible for a variety of activities within the assigned unit(s). The second type of SAT is job specific. This type is responsible for promotion of certain crops which the LNO management has determined to have good potential for commercial

production and which, if successful, will provide farmers with a satisfactory income.

This second type of SAT has been playing an especially important role in assisting several private sector pilot projects in the LNO area. In one seed production pilot project, the firm conducting the production test has no staff at the site, but rather relies on two SAT members to supervise all aspects of the test. Other SAT members are assisting with the pre-production phase of a tomato project, a tomato seed production project, and a cantalope seed production project. This type of service is expected by the LNO management to attract the interest of other agro-business firms looking for investment opportunities.

The SAT is not intended to be a permanent component of the LNO project, but no timeframe has yet been set for its disbandment. As the number of agro-business firms operating at LNO grows, the need for the SAT will diminish since most firms will prefer to use their own employees for regular operations. Some of the SAT may find employment with these firms, and some private sector concerns have already contacted the LNO office with offers to hire SAT members.

4.0 REVIEW OF LNO OPERATIONS AND MAINTENANCE

4.1 Physical Features of the LNO Irrigation System

As for the physical features of the irrigation and drainage system, the project essentially had accomplished most of its goals by the end of 1985. Construction of the LNO Dam was completed in 1973. In the period from 1973 to 1980 the left and right main cement lined canals and their cement lined laterals of 314 km were constructed and 157 km of drainage canals were completed by 1985. About 165 km of laterite surfaced and 33 km of asphalt surfaced roads were constructed in the same period. The following table summarizes the planned and accomplished irrigation facilities of the project.

Planned and Accomplished Irrigation Facilities of the
LNO Project Through 1985.

Facility	Planned	Accomplished	Year Completed
Main and secondary canals	314 km	314 km	1974-1980
Drainage channels	178 km	157 km	1978-1985
Roads	300 km	198 km	1974-1980
On-farm system			
-intensive	26,000 rai	8,514 rai	1976-1985
-extensive	174,000 rai	177,286 rai	

Due to a lack of manpower, equipment, and budget, the main canals, especially a portion of the left main canal, and their laterals were deteriorated by the end of 1982. A "catch up" maintenance plan recommended by Gaylord Skogerboe was partly

implemented in the period of 1983 to 1985 bringing the system back to good condition. By 1980, four low-lift electrically powered pumping stations were installed. At an average lift of about 5 meters, about 38 percent of the total irrigation demand will be pumped.

During the period from 1978 to 1985, on-farm ditch distribution systems capable of irrigating 185,800 rai of farm lands in wet season were completed. There are two major types of on-farm system in LNO project area. The first model (referred to as the Chao Phraya or intensive model) involves land clearing and leveling followed by realignment of farm boundaries and rebuilding of paddy dikes which was later found not suitable to LNO area because of the very high cost (6,500 baht per rai) and significant damage to thin, fragile topsoils typically found in the Northeast. This intensive model was, therefore, applied to only 8,514 rai of farm lands although it was originally designed to cover about 26,000 rai in the project paper.

The second model (called Ditch and Dike or extensive model) was applied to the rest of 174,686 rai of irrigable farm lands. This model involves virtually no land leveling. RID constructs irrigation canals to the farm turnout (via tertiary canals) canals and drainage canals. The farmers are expected to construct the channels to convey water from the turnout to their farm lands. The irrigation and drainage canals of this model are constructed following natural contours to the farm turnout thus eliminating the need for land leveling but being less efficient

in distributing water. The advantages of the Ditch and Dike model are that it is inexpensive (800-1,200) Baht per rai), does damage topsoil and incorporates farmer participation.

A third on-farm distribution model (called Lam Nam Oon or modified Ditch and Dike model) was specifically designed for the LNO Project by the consulting engineer. Construction of this model was limited to an experimental pilot area of 2,600 rai. In this model, the on-farm ditches are relatively shorter than in the traditional ditch and dike pattern. The objective of the Lam Nam Oon model was facilitate the transportation of water to all plots in a chaek, for under the ditch and dike pattern it had been found that those near the end of a long on-farm ditch often had difficulty in receiving the water they required. The shorter ditches in the LNO model required the construction of more ditches, and consequently more irrigation structures, than would be needed with the ditch and dike pattern. Therefore, the LNO model is slightly more expensive to construct. While the area incorporated under the LNO model is small, the effort to implement this model was instrumental in the decision by RID to abandon its plans to continue constructing the intensive model and to adopt the traditional ditch and dike pattern in its place. As a result of this decision, RID was able to achieve major savings in the cost of the LNO project. This also benefitted many farmers who are expected under the land consolidation program to pay for a part of the on-farm construction.

4.2 Maintenance of the Main Distribution System

Procedures for maintenance of the LNO irrigation system (main canals, laterals, sub-laterals, and other hydraulic structures) is similar to that of any other RID's irrigation projects. It is usually done on a remedy or catch-up basis rather than on a preventive basis. This is basically due to the lack of qualified manpower, equipment, and budget. The figure on the following page illustrates the maintenance procedures used at LNO.

Each fiscal year, usually during the dry season, zonemen will survey the system, report on damage, and provide an estimate of repair work required to the Operation and Maintenance (O&M) Section of the Project. The O&M Section will then estimate costs, prepare a list of maintenance works and budget, and submit it to the Project Director to be integrated with other budgetary requests for the project. These are then sent to RID through the Fifth Region Irrigation Office in Ubon Ratchathani.

The O&M Section at LNO is responsible for carrying out repairs and maintenance after the budget is allocated. Occasionally, additional funds may be made available for urgently needed repairs of unforeseen damage which is seriously disruptive to the operation of the system. However, such emergency funds constitute only a small portion of the typical annual allocation for operations and maintenance.

Within RID, the major budgeting emphasis is generally placed on new construction, thus limiting the availability of O&M funds. There has been no exception in the case of the LNO Project. The budget provided for O&M work at the LNO Project has always been insufficient. Because of this inadequate budgeting and lack of manpower and equipment during the period from 1975 to 1981, severe damage had occurred to the linings of canals, many water control structures had been damaged, a great deal of sedimentation had occurred in all canals and laterals, and there was an extensive accumulation of aquatic vegetation in the canals.

In response to the recommendations of a project evaluation team in 1981, a study was completed during the second half of 1982 which recommended a repair and maintenance plan covering the work and costs involved to rehabilitate the irrigation system. The plan consisted of two types of maintenance - "catch-up" and "preventive". The "catch-up" maintenance was needed to correct major deficiencies of the system due to deterioration which threatened its continued operation. The total budget estimated for a 5 year catch-up maintenance plan starting 1983 was 34,700,000 Baht. RID, however, modified the plan to suit its budgeting constraints and allocated a budget of 22,299,000 Baht over the last 3 years for the necessary repair and maintenance works taking the recommended plan as a guideline.

Field observations of the irrigation system during the two week visit to LNO for the present evaluation revealed that the system is now in a very good condition. In fact, a very experienced irrigation engineer from Kasetsart University rated its condition as one of the best in Thailand.

The proposed maintenance plan also suggested an increase in O&M manpower and purchases of various maintenance equipment. Unfortunately, the maintenance equipment proposed for acquisition using USAID funding was not purchased due to procurement problems. The existing number of O&M personnel responsible for the whole irrigation area (not including the resettlement area) is at present about 180 in comparison to the required number of 366. Also, each zoneman is taking care of more than 10,000 rai of irrigated land, whereas 5,000 rai per a zoneman is a more realistic area.

Given the present financial situation of the Thai government, shortages of qualified manpower, insufficient equipment and inadequate budgets will continue to be serious problems at LNO. Top RID officials indicated that they expect a 12% increase in the O&M budget for next year. If this increase materializes, it will permit a substantial improvement in the quality of O&M at LNO. Moreover, RID is now considering the designation of four model irrigation projects to test and demonstrate the benefits which can be obtained from adequate levels of regular preventive maintenance. LNO in the Northeast and the Mae Faek project in the North have already been selected

and several projects in the Central and Southern regions are now under consideration. These four projects will be placed under the supervision of a new unit within RID. In addition to O&M activities, this unit will also be responsible for initiating and coordinating the activities of other agencies which are necessary for the success of irrigated agriculture.

Apart from increasing budgetary allocations for O&M, there are several other things which RID should do to upgrade its maintenance capability.

- (1) Improve the capability and efficiency of the existing O&M personnel through technical, on-the-job training.
- (2) RID should establish a contingency fund for emergency maintenance to be used to hire contractors or temporary laborers and to purchase maintenance materials.
- (3) Develop a long-term program for technical training and continuous non-formal education of the water user groups so that some of the above-farm O&M work, such as removing of sediment and aquatic vegetation from the sub-lateral canals, can be gradually transferred to the water users.

It is difficult to estimate how large a buffer fund would be sufficient for the LNO irrigation system. However, a rough estimate can be made as follows: The average regular O&M budget for LNO over the last three years was 2,840,000 baht per year. Due to this inadequate level of O&M funding over a period of approximately six years "catch up" repairs were required costing 22,299,000 baht. Distributing this amount over the six years results in an average of 3,717,000 baht per year. This

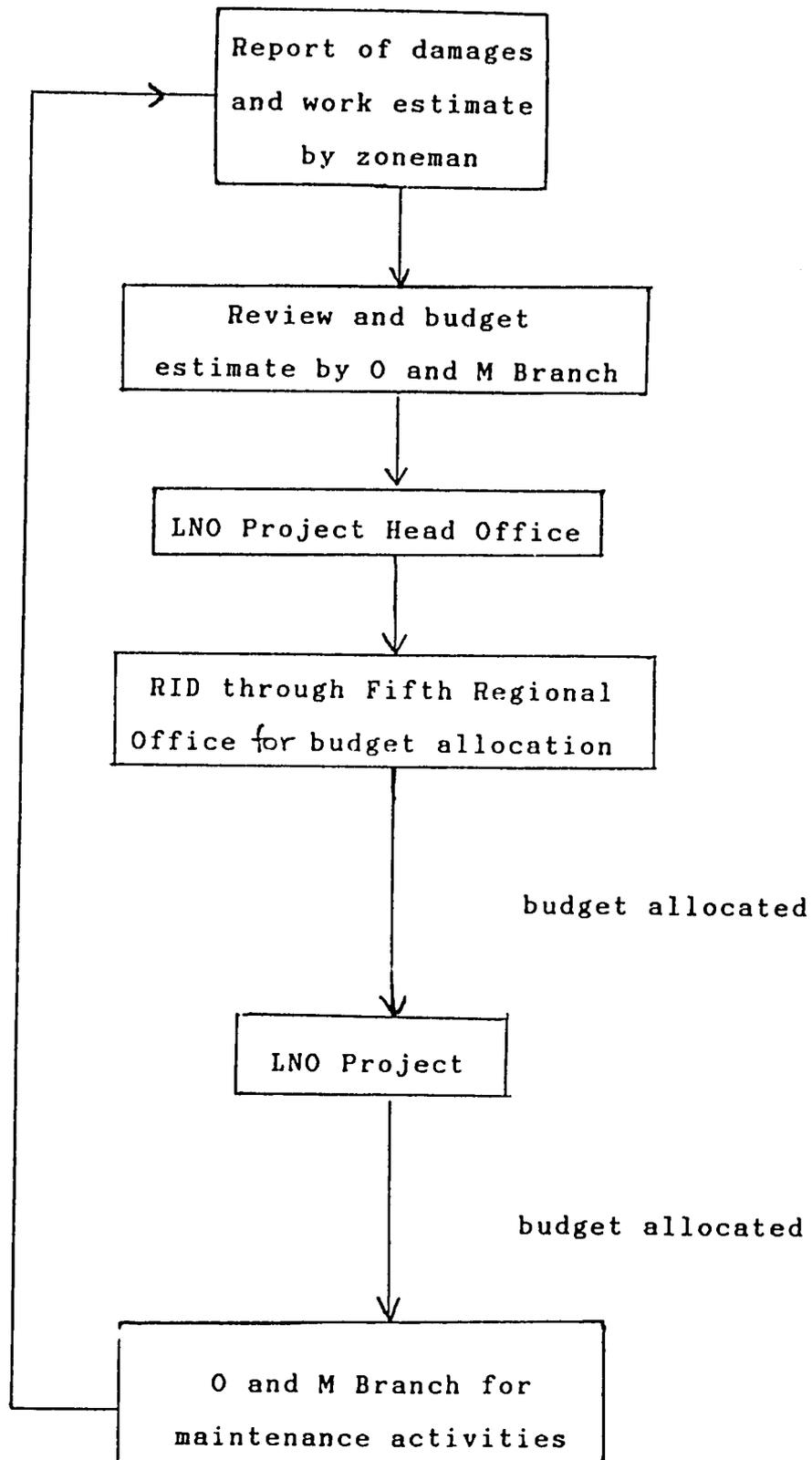
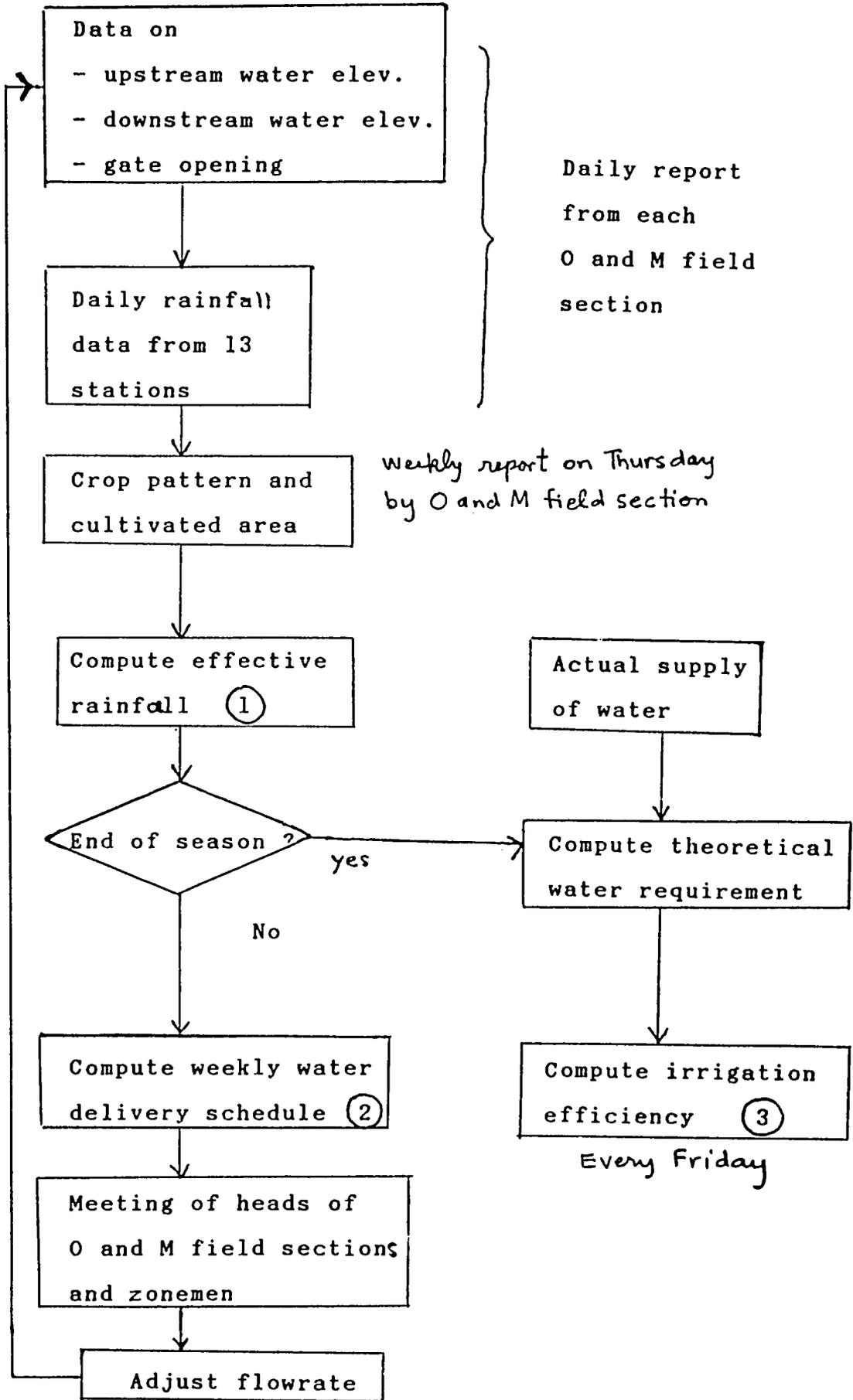


Figure 4.2

Flow of Information for Repair and Maintenance of Irrigation System at LNO

6/7a

Figure 4.3



Daily report
from each
O and M field
section

Weekly report on Thursday
by O and M field section

Every Friday

LNO Irrigational System Operation Model

should be the amount of the buffer fund. In other words, the minimum O&M budget should be at least 6,557,000 Baht per year. The figure needs to be adjusted each year to account for actual maintenance costs and inflation.

The figure above does not include the cost required to operate and maintain four pumping stations in LNO irrigation system which was about 1,144,200 Baht in 1985. Breakdowns of the cost are as follows:

Electricity Costs for LNO Pumping Stations
Right and Left Main Canals - 1985

Pumping Station	Dry Season*		Wet Season		Maintenance Cost (Baht)
	Operating hr./day	Electricity Cost, Baht	Operation hr./day	Electricity Cost, Baht	
L-1L	10.1	73,892	11.0	136,231	5,149
L-3L	-	12,525	0.5	356,415	12,651
LMC at KM 16	-	9,996	12.5	257,928	15,332
R-6L-2L	5.4	39,990	10.5	198,064	77,983

Note: * For an irrigated area of about 8,000 rai in 1985.

The 1985 electricity cost of about 1 million baht for running the four pumping stations in the wet season has been consistent during the last few years, so it can be taken as an estimate of the cost for future operation. In dry season, however, it is not possible to accurately estimate the electricity cost due to its dependency on the total area and distribution of irrigated land. Analysis of past expenditure records coupled with an anticipated dry-season cropping area and

its distribution over the project area can provide a rough estimate of electricity cost in the dry season.

The electricity costs for the main irrigation system appear quite low in comparison to those which RID must pay to operate the four large pumps for the Lam Oon Self-Help Land Settlement. The settlement has an irrigable area of about 10,000 rai, but only a miniscule portion of this is used for irrigated agriculture. Nevertheless, RID must pay substantial amounts each month to supply water to the area as shown in the following table.

Monthly Electricity Charges for Pumping Irrigation Water
Nam Oon Self-Help Land Settlement (1984-86)

December	1984	15,000
January	1985	116,532
February	1985	94,068
March	1985	82,836
April	1985	84,240
May	1985	13,042
June	1985	54,756
July	1985	280,800
August	1985	252,720
September	1985	349,340
October	1985	117
November	1985	209,492
December	1985	153,215
January	1986	117,936

Source: LNO O&M

4.3 Operation of Above-Farm Water Delivery System.

Surprisingly, the operation of many irrigation systems in Thailand, with the exception of the Chao Phraya Project, is done on a trial and error basis. That is, the operation of the water delivery system from the reservoir down to the farm level

is based on the past experiences of zoneman and engineers, rather than on systematic operational procedures. In this regard, the LNO irrigation project has had a good start, with initial technical inputs from the consultant, in developing a systematic operational model for an irrigation system. A flow chart of this model is shown below.

The O&M branch of the project is responsible for the planning of weekly water delivery schedule. The O&M field sections report daily on the water elevation upstream and downstream of each gate, settings for gate openings, rainfall data. Weekly reports on cultivated crops and area are also made. When the new computer model is operational the engineer in charge will compute the effective rainfall and then the flowrate required at each gate. A meeting of the heads of each O&M field section and zonemen is held every Friday to discuss the operational schedule for the following week and give assignments to the zonemen. Eventually, it will be possible at the end of each growing season to compute the efficiency of the entire irrigation system. This measurement can then be used as an index to indicate changes in the quality of system operation.

At the present time, the O&M section uses an Epson QX 10 micro-computer. An Apple Three micro-computer previously owned by the consultant engineer was purchased by the Project Field Director for use by project personnel. The water management system currently used at LNO consists of three sub-

programs for the computation of effective rainfall, the weekly water delivery schedule and weekly irrigation efficiency. Each was developed by the consultant engineer in close collaboration with RID engineers at the LNO Project in order ensure effective transfer of this new technology from the consultants to the O&M personnel at LNO. The original water management system included only the RMC.

A new water management program, covering both the RMC and the LMC has recently been developed by the Deputy Chief for O&M at LNO. This program was adapted during a one-year training program he attended at the university from the Utah State University "Main System Model" to fit the characteristics of the LNO irrigation system and environment. The program, which is capable of computing water requirements for each chaek, will undergo operational testing on a Hewlett-Packard 9836 micro-computer beginning June 1986 when a team from Utah State will be at LNO under a USAID sponsored Water Management Synthesis Project.

One important limiting factor for continuous application of this systematic approach in operating the irrigation system at LNO is the lack of qualified man power. One LNO engineer who was directly involved in developing the approach and computer programs was transferred into RID's Water Management and Operation Branch in Bangkok. At present, there is only one competent, well trained engineer in charge of computer applications. He is assisted by two qualified programmers. One

staff member who previously worked closely with the consulting engineer during the development of the original water management model is now completing his studies at Kasetsart University, and is expected to rejoin the project this year. The LNO Field Director and the Deputy Field Director for O&M are both supportive of using the computer for operating the irrigation system. The Deputy Director General for Maintenance and the Director of the Operations and Maintenance Division have also expressed their support for the development and use of computerized water management systems. It is, therefore, strongly recommended that:

1. The approach being developed at LNO for the systematic operation of the irrigation system be allowed to go on for a few years in order to test its effectiveness, determine training requirements and assess the replicability of the approach for other irrigation systems in Thailand. RID's Water Management and Operation Branch, which is at present the only unit having personnel capable of applying this systematic and microcomputer based water management, should closely observe the efforts of the LNO staff in this effort.

2. All of the engineering staff at LNO should be trained in the objectives and procedures of the computer-based water management system. Other staff, particularly zonemen should receive training in the accurate collection of necessary data and on the importance of their role in the successful employment of this system.

3. To insure the continuity of the forthcoming test of the computer-based water management system, essential personnel such as the Deputy O&M Chief should not be transferred from LNO at least until clear evidence has been obtained on the operational merits of the system.

It should be noted here that William Bell's (former consulting engineer at LNO) computer programs on the Board Crested Weir Design, Computation of Flow Through an Orifice, and Computation of Back Water Curve were useful in developing the original computer-based water management system. While they are no longer used, Mr. Bell's training of RID personnel on micro-computer systems provided them with the basic knowledge to operate the newly developed system.

4.4 Operation and Maintenance of the On-Farm Irrigation System

The on-farm water delivery network is relatively new. Field observations at random spots reveal that the farm ditches and facilities are in good and operable condition. On-farm O&M is not expected to be a problem in the short-term. The long-term quality of O&M will very much depend on the strength of the water user groups. A study of the behavior of the water users groups would be useful in providing some insight into ways of improving on-farm O&M in the future.

Interviews with 19 water users groups selected by the project staff to represent both good and poor groups indicate that the farmers do not feel they have any major difficulty in carrying out their operations and maintenance responsibilities. Those interviewed reported that they spent from two to five days carrying out routine maintenance (cleaning, removing sediment, and repairing damage) on the farm ditches. The chairman of the groups might have to spend a little extra time in organizing the maintenance.

The groups have similar regulations concerning the obligations of members and penalties for those who do not fulfill their responsibilities. Among the groups interviewed, it was reported that those who do not participate in scheduled maintenance activities are fined at a rate of 30 to 50 Baht per day and those who cause any damage to the on-farm facilities or seriously violate the regulations incur a fine of 300 to 500 Baht.

Most interviewed farmers told the evaluation team that they learned about the on-farm management works, the important roles of farmers in maintaining farm ditches, and other subject areas useful to them from the Bang Fang Dang Rural Development Training Center. The evaluation team visited the center and interviewed the head of the center and members of the staff. The efforts the staff put into training the water users groups was very impressive. The center did not only provide classroom lectures on basic subjects related to irrigation and irrigated

agriculture, but also on-the-job training in how to operate and maintain the on-farm irrigation system and other related subjects using demonstration plots on which a functional mini-irrigation system has been constructed.

The center, however, has been recently facing a shortage of funds with which to run the training program. Two of the four employees working in the demonstration farm land and two office personnel are at present temporarily supported by individuals who see the various roles of the center as important for the successful operation of the LNO Project. Analysis of past few year records indicates the cost of training was 30 baht per trainee, which is comparatively low.

Based on observations and interviews with water user groups in the field and the activities of the Ban Fang Daeng Center, two recommendations regarding the on-farm management at LNO appear to be in order.

1. Continuous monitoring of the performance of the water users group should be carried out to provide information for future development of a long-term plan for on-farm management, as well as to assess the possibility of transferring responsibility of operating and maintaining some minor parts of the above-farm distribution system to farmers.

2. When the benefits of the Ban Fang Daeng Center are compared to the low training cost of 30 baht per trainee, it is

apparent that the center is a valuable component of the LNO project. The center should continue to receive financial support from the government. In addition, a long-term program for training in various subjects, including the specification of target groups, should be drawn up jointly by those agencies with direct responsibility for achieving the objectives of the LNO project.

5.0 Review of Economic Benefits - LNO Integrated Rural Development Project

5.1 Project Background

The LNO Integrated Rural Development Project was designed to meet a number of objectives beyond the provision of on-farm irrigation and increased agricultural production. In addition to research, extension, inputs and marketing activities designed to support the agricultural production objectives, the project includes community services designed to meet social objectives. In terms of the rural development aspect, numerous outputs existed in terms of numbers of families or villages involved in various activities and organizational arrangements. These were largely aimed at agricultural production, but also included health and family planning, a variety of training programs, and increased fish production.

The overall project objectives were set in broad terms referring to the improvement of quality of life of the families residing in the project area. The LNO Irrigation project seeks to raise the income of the LNO population, thereby decreasing dependence on aid from the government. In regards to the on-farm agriculture in the LNO project, 4 agricultural activities were examined for their current status: water management, (on-farm systems, soil improvement practices and agricultural communications. Originally (1977) the LNO project began specifically as an irrigation project, but was broadened into an integrated rural development project. A special feature of the

project has been the on-site management arrangement under which representatives of several Royal Thai Government (RTG) departments involved developed joint or closely coordinated activities contributing toward common objectives.

This evaluation of the LNO project essentially examines impact issues from the perspectives of the direct beneficiaries and of the benefits to the economy as a whole. The principal benefits analyzed are those anticipated from the second cropping during the dry season.

In order to achieve the objective of increasing agricultural outputs and improving the benefit distribution, the promotion of dry season crops was suggested as the primary channel for implementation. In order to increase the agricultural outputs, the promotion program of dry season crops emphasized three main factors (1) efficient water distribution, (2) transfer of technology, (3) marketing of farmers' produce. The effectiveness of the program depended on its ability to perform the main activities successfully. To measure the effectiveness in general, variables such as those listed below, were considered for evaluation:

- a. The marketing network and merchant relationship of dry season crop production;
- b. Net return to farmers for various crops;
- c. Problems concerning yields, lack of credit, other inputs, water delivery and the size of the market;
- d. Area to be expected for the planting of each crop.

5.2 Evaluation of Project Benefits

5.2.1 Cost Benefit Analysis

Cost benefit analyses made for LNO in the past vary according to assumptions made and the calculations used. For example, the 1967 Project Paper ignored the capital investment in the dam and irrigation system and showed a benefit-cost ratio of 2.95 and an internal rate of return of 25.8%. In the 1977 Project Paper, the internal rate of return was estimated at 10.2% and the benefit-cost ratio at 1.29. The authors of that paper admitted that these levels were not very attractive. However, a later evaluation of LNO in 1981 used more realistic assumptions and showed the 1977 Paper's estimates of IRR and B-C ratio to be unrealistically high.

5.2.2 The 1981 Evaluation pointed out that the 1977 Paper did not take into consideration production foregone by farms drowned by the reservoir. Furthermore, the 1977 Paper optimistically assumed dry season irrigation would expand to 68,000 rai by 1981. In fact, the area only expanded to 20,000 rai by that year. An 8% discount rate and 50 year project life were used in the 1977 calculations. If a higher discount rate and 30 years project life had been used, the economic return of the LNO project would have appeared unacceptable. The 1981 Evaluation also noted that, if the actual irrigable area turns out to be much lower than the design area, the economic benefits of the project would become extremely poor in relation to the capital already invested.

5.2.3 Like the 1981 Evaluation, capital investment costs are not included in the cost-benefit analysis presented below. This analysis only takes into consideration the on-farm development component. It is considered that the physical and social infrastructure that was introduced in LNO served the purpose of politically stabilizing the areas surrounding the project site. Seen in this light, LNO's capital investment has saved the government the expense of using military means to achieve the same goal and the loss of life this would involve. By not taking into account capital investment, this analysis hopes to measure the on-farm development component which is considered as the extension of an already constructed irrigation project.

5.3 Benefits

5.3.1 Calculation of the benefits of the project required a determination of the cropping patterns. These were determined by interviews with the Department of Agriculture, the Office of Agricultural Economics, the Department of Agricultural Extension, The Department of Non-Formal Education, The Department of Fisheries, The Department of Community Development, The Bank for Agriculture and Agricultural Cooperatives, Commercial banks in LNO area, the Department of Agricultural Cooperative Promotion, merchants and the private sector dealing with LNO area, LNO staff and the farmers. It was found that cropping pattern was decided by considering the availability of labor, efficiency of water distribution, and past returns.

5.3.2 Although wet season non-glutinous paddy gives high economic return (See Table 1) its price is quite unstable. Hence it is excluded in the calculation of benefits. Although non-glutinous milled rice has a higher stability in price, it is not relevant here because the farmers usually sell the un-milled paddy, for the present analysis the un-milled paddy is a better indicator of the farmers' benefit from the LNO Project. See Table 2 for instability of crop prices. The benefits also excluded benefits from the reservoir proper; e.g. fishery benefits from the reservoir, tourism, household water consumption from the reservoir, and the water for agriculture uses in up-stream areas are not included in the benefit stream.

5.3.3 OAE found that, on average, 7% of irrigable land was cultivated in the 1984/85 season. For purposes of calculation, 10% was assumed.

5.3.4 Other data from the OAE evaluation team was taken and adjusted to reflect the economic price of the crops:

- a. Assuming a shadow wage rate of 83%, the daily shadow wage rate was determined as 25 baht per day.
- b. All other inputs (seeds, fertilizer, pesticide, insecticide) excluded 10% indirect tax.
- c. Rent and depreciations are also excluded.

5.3.5 Table 1 gives the Financial and Economic returns of crops. Tables 3a and 3b show the cropping intensity

and cropping pattern assumed in the cost-benefit analysis. The total incremental benefits of the project are given on Table 4.

5.4 Costs

5.4.1 On-farm development costs come from the 1981 AID Evaluation. The on-farm development costs for the Ditch and Dike and Modified Ditch and Dike (LNO) models were given by the LNO project office.

5.4.2 Operation and maintenance costs for the total system for the years 1977 to 1981 come from the 1981 AID Evaluation. Post 1981 data comes from the LNO project office reports. Included is all the cost for development of industrial agriculture as well as costs for the Specific Assignment Teams (SAT).

- 5.4.3 Other assumptions in the calculations of costs:
- a. 5% annual inflation adjustment up to 1985.
 - b. Exchange rate of \$1 equals 27 baht. This is a conservative valuation. It is possible to use the exchange rate of \$ 1 equals 26 baht.

5.4.4 Project costs are presented in Table 5.

5.5 Analysis

5.5.1 Assuming a project life of 30 years (1976-2005) and a discount rate of 12% per year showed a cost-benefit ratio of 1.10943 and an internal rate of return of 15.5. These levels

are considered to be satisfactory. They pass all the conventional requirements for water resource projects, as imposed by the World Bank or Asian Development Bank. If a discount rate of 15% is assumed, the cost-benefit ratio is still higher than one at 1.01576.

5.5.2 It must be mentioned that these estimates are very conservative. The wet season non-glutinous rice cultivation was not included in the benefits after 1985. The dry season non-glutinous rice is assumed to increase to 1979 level by 1990 and onward. The assumption is made for the purpose of calculating cropping intensity. In estimating the incremental benefit of LNO project the dry season non-glutinous rice after 1985 is not included.

5.6 Sensitivity Tests

5.6.1 Since the benefits of non-glutinous rice in the wet season were not considered in the base cost-benefit analysis, sensitivity analyses were conducted to test for this and other variations. The results of the sensitivity tests were encouraging (See Table 6).

5.6.2 Case I assumed non-glutinous rice in the wet season to be included in the benefit stream. A very high discount rate of 35% per year was assumed. The cost-benefit ratio was still positive at 1.0904 and the IRR was quite high at 43.9.

5.6.3 Case II assumed cost to be 5% higher than in the conservative Base Case. A 12% discount rate, the rate conventionally applied to water resource projects, was assumed in this case, the B-C ratio was 0.965 and the IRR 11.75%. Here the B-C ratio was close to one and the IRR was near 12%.

5.6.4 If a project shows an IRR above 12%, it is considered a viable project. Given this criterion, Cases III and IV were tested for variations of benefit. An increase in and a decrease in benefits of 5% were tested. In each case, the IRR was 14% or above.

5.7 Kinds of Benefits and Factors Contributing to Benefit Variation in the Project Sub-Areas

5.7.1 Kinds of Benefits. The general overall benefits of the project are as follows:

- a. Water is available when needed for irrigation.
- b. Water is available for fish ponds
- c. Flooding near the natural river bed is relieved.
- d. Water is available for household use.
- e. Because the water table in the area has risen, drinking water is more accessible through wells.

5.7.2 Factors Contributing to Variation of Benefits:

- a. Distribution of water varies depending on the topography of the land. Farms located on hilly ground may have trouble receiving water. This is especially true if the farm is far from the supplying canal.

b. In the 23 units receiving water for crops, land holding varies from household to household and, in general, those with the larger holdings get better yields. There are also differences in soil quality which affect yield. The soil in some areas have salinity problems while the areas with Phi Mai soil are much more fertile. With proper fertilizer use, the difference would not be so great.

c. The farmer's ability to predict the market and choose a profitable crop to cultivate also contributes to the variation of benefits. For example, farmers who chose to cultivate glutinous rice last year did better than those who grew regular rice because of a rise in the price of glutinous rice. Obviously, the varying abilities of the farmers in each unit as farmers determines how much benefit he can take.

5.7.4 Incremental Benefit Generated by the Project Sub-Areas:

a. A measure of the added economic benefit for each sub-area is presented in Table 7. Figures for the actual incremental benefit for the crop year 1984/85 were used in the present analysis. The benefit was divided by the acreage in each of the subareas. Obviously, the size of land is the major factor to show how much benefit a sub-area or household receives.

b. The calculation did not take into account benefits generated for sales of glutinous rice and livestock (chicken, buffalo, etc.). The drop in home consumption of

glutinous rice due to the effect of income elasticity also was not taken into consideration in keeping with the OAE's 1984/85 evaluation of LNO integrated development. Household consumption of glutinous rice for home consumption was 53.73% and that for non-glutinous rice was 2.0% of the total production per household. The figures used here only measure economic benefit added by LNO irrigation. Benefits from fish pond production were included as it is water related.

5.8 Comparison of On-Farm Irrigation Models

5.8.1 A comparison of the cost/benefit between three irrigation models: (1) Land Consolidation (Intensive) Model; (2) Lam Nam Oon (Modified Ditch and Dike or modified extensive) Model; (3) Ditch and Dike (Extensive) Model was made to determine which model yields the most economic benefit.

5.8.2 In comparing the three models, it was assumed that they were all equal in terms of the following non-water variables:

- Extension effort
- Cropping pattern
- Soil type
- Topography
- Farmers' entrepreneurship, management ability, access to the market and factor inputs.

5.8.3 By discounting non-water variables, the relative cost/benefits of the three models were made to reflect their relative efficiency of water distribution. The comparison

shows (1) the Land Consolidation Model to be the most efficient, followed by (2) the Lam Nam Oon Model and then the (3) Ditch and Dike Model, in terms of water distribution.

5.8.4 However, when the relative construction costs of the different models are taken into consideration, they rank in the opposite order in terms of economic benefit. Construction costs of the (3) Ditch and Dike is set at 2,100 baht per rai, the (2) Lam Nam Oon Model at 2,500 baht/rai and the (1) Land Consolidation at 9,214 baht/rai. Expressed in ratios, the relative construction costs of [(3) to (2) to (1)] are 1 : 1.19 : 4.4. In other words, the Land Consolidation Model costs over four times the amount to build either of the other two. Even if the Consolidation model is a more efficient water distribution system, it would have to be more than four times more efficient to yield the same economic benefit as the other two. This is impossible as the difference in water distribution efficiency between irrigation models does not vary to this degree.

5.8.5 Comparing the LNO model and the Ditch and Dike, it is found that the difference in crop yields between the two is not significant. Hence it is difficult to determine which model will generate a better cost-benefit ratio or will provide a better economic return.

6.0 Review of Production and Marketing

6.1 Introduction:

The Northeast has an extensive agricultural marketing system which is able to handle a wide diversity of crops. In the past LNO farmers were not involved with this marketing system to any great extent, especially with respect to dry season crops. However, there were a few farmers who did produce high quality raw materials for sale to middlemen and processors. The marketing effort undertaken at LNO between 1981 and 1985 focused on expanding the linkages between LNO farmers and the existing marketing system, particularly in those sections of the project area where construction of on-farm water delivery systems had been completed, providing farmers with reliable supplies of dry season irrigation water.

The basic approach was to identify potential market linkages, train farmers to produce selected crops for specific existing markets, and to produce sufficient quantities of high quality produce in order to attract the attention of additional private sector interests to the agro-business potential of LNO.

The objective of increasing private sector involvement at LNO derived in part from the poor performance of several attempts by the government to encourage dry season cropping at LNO by means of price and purchase guarantee schemes. The failure of these attempts coincided with the emergence of the Joint Public-Private Sector Consultative Committee chaired by the Prime Minister. The purpose of this national committee was to provide a forum for discussion of basic issues related to

economic development and to help reduce the suspicion and animosity which had characterized relations between the government and private sectors up to that time. Thus the LNO marketing initiative received legitimation from the highest levels of government during its crucial beginning stages, and reinforced the resolve of officials at LNO who had already accepted the need for substantial private sector participation in the development of the area.

6.2 Description of Activities:

The marketing program introduced at LNO consisted of three elements: market research, marketing extension, and market development.

Market Research

The market research component concentrated on the identification of crops which could be produced at Lam Nam Oon and markets which would serve as outlets for those crops.

Initial efforts focused on the identification of crops already being produced by farmers in the Lam Nam Oon irrigated area. At the same time, problems related to production of those crops were researched. Of special interest were problems related to water delivery and water management, quality control of produce, level of agricultural technology employed, prices obtained for the crops, and the locations of markets where these crops were traded.

Once existing markets had been investigated, further research was required to identify additional outlets for farmers' produce at local, regional, national, and international levels. The objective being to provide farmers with alternative market opportunities where higher prices could perhaps be obtained. In depth research was conducted at markets at each level in order to establish price variation patterns and trading practices specific to each outlet.

Linked to the research conducted at markets at each level, was the identification of existing marketing channels. The purpose in this being to be able to advise farmers on which channel would bring them the highest returns. In addition, marketing channels which were only slightly developed were also studied for their potential for further development. It was also important to determine the flow of agricultural commodities from the Lam Nam Oon area in order to learn the price margins which would be expected by potential traders, processors, and investors

The identification of key traders or middlemen in each principle outlet was an important objective of the market research. It was necessary to establish the commodities and volume traded by each major trader. It was also necessary to understand the problems each of these middlemen had in the wholesaling and retailing of agricultural commodities.

Finally, market research was undertaken to identify the raw materials needs of private sector traders and processors. In this case, the owners of processing and canning factories were contacted. Crops with the potential of being produced at Lam Nam Oon were identified and details regarding price and quality standards were discussed.

- Marketing Extension

The Ban Fang Daeng Rural Development Training Center served as the principal channel through which market information was transferred to farmers. As the results of market research became available, this information was incorporated in the curriculum for water user groups and others trained at the center.

6.2 Marketing training covered the following topics:

- seasonal crop price variations at local markets, with an emphasis on crops produced or with the potential for being produced
- off-season production techniques
- the importance of a mixed farming system
- production of vegetable crops as a group on a rotating basis to better meet market demand
- contact and relations with vendors
- methods of marketing, including packaging and arrangements for selling
- best and most risky crops to cultivate
- location of best local markets for specific crops, names of vendors, middlemen, and processors in the area.

Marketing training was also provided to the field level officials working in the LNO area. Presentations to the SAT's and tambon agricultural extension and community development officers covered the same topics as outlined above for farmer training. Two additional topics were included for presentation to extension personnel. These included:

- orientation on the necessity for private sector participation in solving rural marketing problem; and,
- the use of water user groups as the basis for crop production and marketing.

The SAT's were provided with more frequent training and received directives in their weekly meetings at the Lam Nam Oon Operations Center. Members of the Working Group who worked closely with the SAT's insured that three additional topics were discussed frequently:

- the extension to farmers of the concept of mixed farming oriented to local market demand;
- the need to provide selected services to the private sector and how these services were linked to solving the marketing problem at Lam Nam Oon; and,
- the necessity to maintain minimum quality standards of produce.

The objective of training field staff was to help them to better comprehend the market forces at work around them; to expose them to the fact that local outlets existed for promoted crops, so long as minimum quality standards were maintained. Most field staff had had negative experiences in their

interactions with marketing or had heard negative stories. It was necessary to present marketing in a positive light; in a manner which fostered a deeper understanding of local market conditions and the methods used in marketing locally produced commodities.

Familiarizing field level staff with local marketing situations permitted them to talk easily with farmers about marketing problems. The field level staff was presented with solutions to local marketing problems which could be understood by the farmer and were feasible. The long term objective was to transform the farmer into a market oriented producer, demanding technical information on the production of crops under irrigated conditions, to which extension staff would be required to respond.

Other components of the marketing extension program included:

- a monthly newsletter which reported on the prices of selected crops in markets serving the Lam Nam Oon area, with short articles giving observations on local market conditions. The newsletter was made available to agricultural extension, community development, cooperative promotion, and non-formal education units throughout the irrigated area of Lam Nam Oon;
- weekly radio broadcasts would offer local market price information as well as commentary on crops currently being promoted by the Project; and,
- various aspects of marketing and local market conditions were discussed by the marketing advisor with farmers in village meetings of water users groups and at dry season crop promotion campaign meetings.

6.3 Market Development:

The development of markets for agricultural commodities produced at Lam Nam Oon was based on the establishment of links between producers and traders.

Once crops under production had been identified, outlets were sought for those crops. Samples of produce were made available to traders and processors in an effort to demonstrate that Lam Nam Oon farmers could provide the commodities they required. As an incentive to the middleman/processor, central points of sale were established to make more convenient the purchase of commodities. This initial contact between farmers and a new middleman is crucial to any market development effort. Pricing, timing and smoothness of the purchasing operation are essential in establishing a favorable atmosphere-one which would encourage an expansion of private sector participation in the area.

A market development incentives program was designed to encourage investors and the local banking community to consider the potential for agri-business development at Lam Nam Oon. The incentives were designed and based upon the needs of middlemen, processors, and traders as revealed by the private sector in the course of market research. In order of priority, these needs included: credit, source of quality raw materials, and support services.

The private sector incentive program which was adopted by the LNO working groups included the following elements:

- Credit

Commercial lending institutions and investors require evidence of acceptable returns on any agro-industrial venture. Banks require a positive cash flow to insure that credit made available to investors would be repaid, and investors required profit margins which would make their efforts worthwhile.

A series of agro-industrial investment opportunity reports were prepared to demonstrate the feasibility of agribusiness ventures in the Lam Nam Oon area. Reports were prepared pointing out the potential for investment in a groundnut shelling facility and a small canning factory. The production potential of groundnuts, tomatoes, young ear corn, Japanese suyo melon, chili peppers, and rice and groundnut seed was also examined.

Each report recommended the commercial feasibility of the project studied and examined in detail the potential for development at Lam Nam Oon. These reports were made available to major lending institutions in an effort to make them aware of the potential for investment at Lam Nam Oon. When the reports were in English, Thai summaries were provided to potential investors. The reports were used in some cases to support requests for credit from commercial banks to invest at Lam Nam Oon.

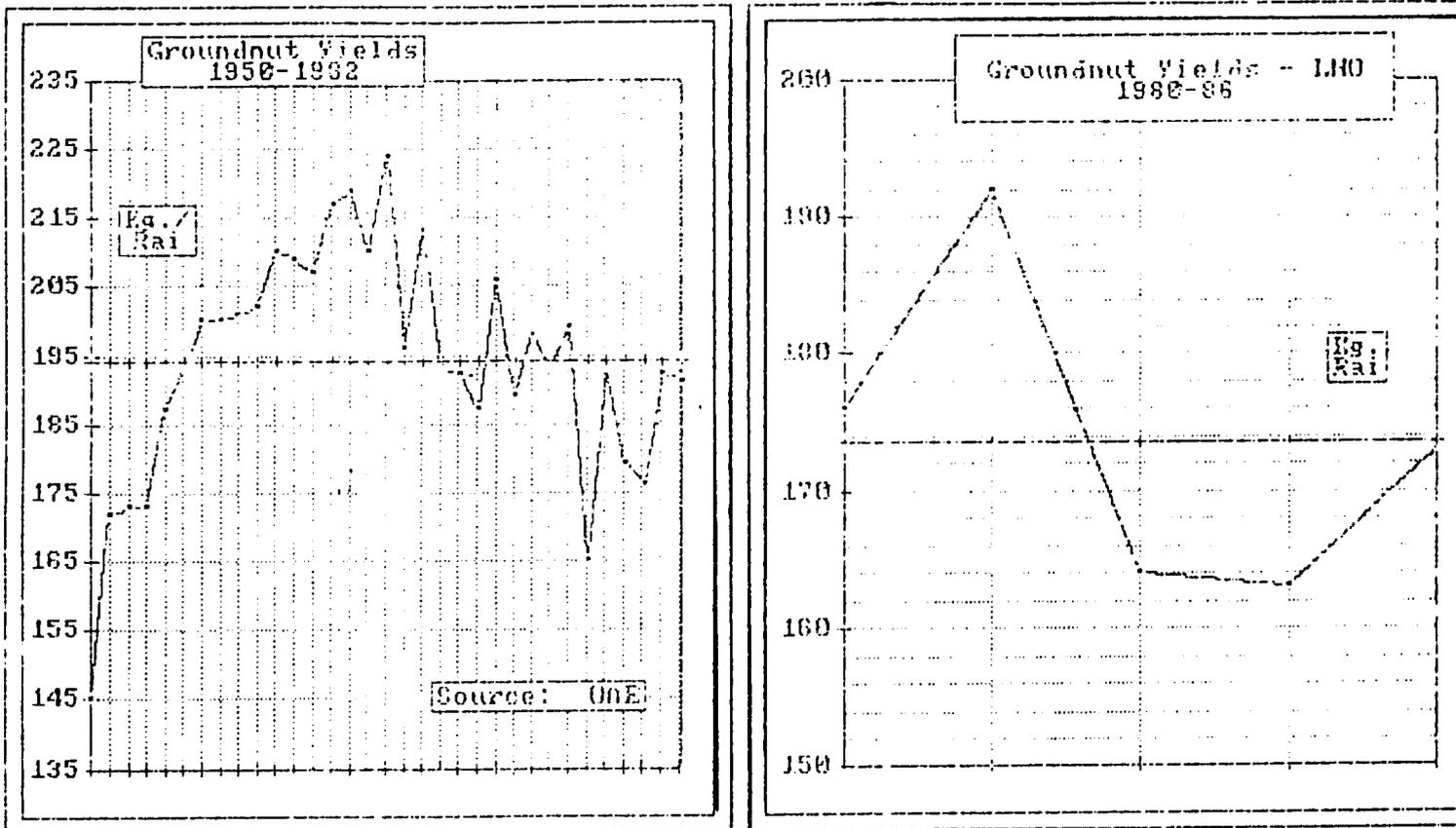
- Quality Raw Materials

Market research revealed that significant excess capacity existed in crop and vegetable processing factories in the Northeast region of Thailand. Owners and managers of these factories reported that even during the peak production season they had to transport raw material for processing long distances to make use of idle equipment even during the peak production season. Processors were especially eager to employ equipment during off-season periods.

Food processing factories in the Northeast could serve as outlets for several crops which could be produced at Lam Nam Oon, including: tomatoes, young ear corn, Japanese suyo melon, pineapples, dwarf cucumbers, beans, peas, and sweet corn. Prices being offered by the factories were adequate - offering a profit to middlemen and a satisfactory return for labor invested by the farmer. But, the quality of produce received by the factories was usually poor, with the result that farmers often received less than the price anticipated. A similar situation exists with the quality of certain field crops. Groundnuts, which have a high production potential at Lam Nam Oon, are a case in point. Processors and exporters of groundnuts throughout Thailand agree that the quality of groundnuts produced are the principal constraint to higher prices and increased exports. In addition, groundnut seed continues to be in short supply as the quality of groundnuts produced are of poor quality and cannot be employed as seed. However, markets exist and can be developed once the quality of Thai groundnuts improves. Long term data on groundnut

production at LNO is not available. As the following figure shows production per rai at LNO remains somewhat below the national average. However, in the absence of comparable data on costs per unit of production and area, it is not possible to satisfactorily evaluate the lower level of groundnut production at LNO.

Figure 6.3



The Department of Agriculture has conducted extensive field research on the production of industrial crops, groundnuts, and other field crops under irrigated conditions in the Northeast (and elsewhere in Thailand) through the 1970's and the 1980's. Therefore, the technologies exist which will insure the quality of these commodities. The mechanisms do not exist, however, to transfer these technologies to farmer-irrigators. Through the SAT's and the marketing extension program at Lam Nam Oon, an attempt was made to provide the farmers with the technologies required to meet the demands of existing markets.

- Services

The services provided to the private sector through the Lam Nam Oon Operations Center served as an incentive to traders and investors not yet familiar with Lam Nam Oon to study the potential for development in the area.

These services included:

- orientation to the Lam Nam Oon area through a briefing in the Operations Center's Situation Room, followed by a short field visit.
- introductions to farmer leaders, key government officials, local middlemen and traders, bankers, and visitors from Bangkok who may be of some assistance to the entrepreneur
- providing information obtained from an evaluation of market research data, including contacts at central and terminal markets who may provide additional outlets for the entrepreneur
- reports and studies to support any business activity the entrepreneur intended to undertake in the Lam Nam Oon area.
- communications facilities

- maps
- assistance from the Special Assignment Team
- publicity for any endeavors undertaken through news conferences, radio, and newspaper publicity
- location of areas for cultivating selected crops.

Under the direction of the Working Group, the SAT assisted traders operating in the Lam Nam Oon area in various ways, such as:

- identification of villages which produced high quality commodities having followed extension recommendations
- guides to accompany the trader's trucks to purchasing points
- organization of farmers to cultivate and sell their produce
- coordination of commodity purchasing, including handling, transporting, and storing.

6.4 Managed Crop Production

A crop specific program of managed production was designed and tested by the marketing advisor during the 1982-85 dry seasons. Vegetable production and marketing groups were organized by the SAT's. In addition, young ear corn and tomatoes were identified as an industrial crop which was in demand by local canning facilities. Production and marketing schedules were prepared for both activities and the managed production system was tested.

The managed production program included special training for participating farmers and SAT's selected as technicians. Special credit arrangements were made with the BAAC and seed and technical recommendations were provided by the agricultural research personnel resident at LNO.

The development of a managed production system was necessary for several reasons:

- to insure a constant supply of raw material to the canning facility or to local vendors (who were required to purchase vegetables from middlemen/transporters);
- to insure some measure of quality control of the produce;
- to demonstrate the feasibility of group production;
- to insure the production of a sufficient volume of raw material for the canning facility; and,
- to demonstrate that market oriented production was viable at Lam Nam Oon.

6.5 Market Size and Consumption Patterns

6.5.1 Field Crops

Groundnuts are the principal field crop produced in the Lam Nam Oon area during the dry season.

Dry Season Groundnut Cultivation

Dry Season	Groundnut Cultivation as % of Total Area Planting	% of Farmers Planting Groundnuts as % of Farmers Planting
1981/82	32	31
1983/84	76	83
1984/85	46	55

At the present time, farmers sell their groundnuts to traders from various provinces of the Northeast (Loei, Kalasin, Ubon), as well as to local middlemen who sell the crop in Udorn, Khon Kaen and Nakorn Sawan (a portion of the groundnuts marketed in Nakorn Sawan are directly exported by container). Some of the groundnut production is processed in the region prior to being sent to Bangkok. For example, there are groundnut shelling factories operating in Ubon, Kalasin, and Surin - a fourth factory in the LNO area closed in 1985 due to poor management, but may be reopened. A significant portion of the groundnuts produced at Lam Nam Oon are consumed in the region as snacks, confection, and food. Only the worst quality nuts, which cannot be consumed are sent to oil extracting facilities.

The market for LNO groundnuts is considered reasonably large. Moreover, the quality of the groundnuts produced at Lam Nam Oon is generally very good when compared to that of those produced elsewhere in the Northeast, and especially when compared to those from the North. Samples sent by project consultants to Italy, Germany, and the Netherlands were well received and of acceptable quality. However, exporters in Bangkok hesitate to take contracts to supply to those markets because of an insufficient and inconsistent supply of the highest quality hand-picked-selected groundnuts.

The DOAE has periodically purchased groundnuts at LNO for use as seed in its disaster relief and upland cropping promotion programs. The additional demand provided by DOAE in

one year, plus the above-market prices paid by the department, has tended to stimulate increased production the following year. However, since the volume purchased by DOAE varies each time it intervenes in the LNO market, the effect is to generate a boom and bust cycle for groundnut producers.

A final influence on market size is the variety of groundnut now being produced by Lam Nam Oon farmers. The Tainan 9 variety has been promoted in the Lam Nam Oon area by Government agencies for more than five years. This variety was introduced to produce groundnuts for the domestic vegetable oil market which is presently depressed, and will probably remain so, as the supplies of palm oil and coconut oil increase due to over production in other regions of Thailand. Groundnut oil is only blended with these oils, never sold as groundnut oil, and thus demand is likely to remain low. Both domestic and export markets prefer other varieties which have a lower oil content and are more appropriate for roasting, boiling, confection, and snacks. The market size for Lam Nam Oon groundnuts could be significantly increased as a result of a switch to a variety of groundnut with a higher demand potential. The Sukhothai and Lampang varieties produced in Northern Thailand should be tested and tried to determine their suitability to the agro-ecological conditions at LNO.

Other field crops produced at Lam Nam Oon include a local variety of sweet corn, watermelons, pumpkins, and cucumbers. The sweet corn is consumed locally, with the only

outlet being markets serving the Lam Nam Oon irrigation command area. Any significant increase in production would cause prices to fall. The production and marketing of watermelons and pumpkins continue, even after considerable efforts on the part of project staff to discourage production in favor of other crops. The area planted in both crops has decreased between 1980 and 1985/6 dry season, suggesting the success of these efforts. The production of cucumbers in several areas of Lam Nam Oon has been very successful. As with watermelons and pumpkins, marketing has been relatively simple. Local traders as well as traders from other provinces buy these three crops at the farmgate and transport them for sale in Bangkok and other cities along the way. Interviews with farmers show that the area planted has increased steadily from 188 rai in 1983/84 to 400 rai in 1985/86, suggesting that there may still be room for growth in the market for this crop.

Chili peppers is also a field crop which is already successfully cultivated and marketed in Lam Nam Oon. Despite the large volume of chili peppers produced domestically, Thailand must also import approximately 300 hundred tons of dried peppers each year. Moreover, since prices for chili peppers during the late dry and wet seasons can reach 70-80 baht per kilogram, farmers at LNO could benefit substantially from an expansion of chili pepper cultivation.

Types of Dry Season Crops Grown at LNO
1985

53.00% groundnut
 5.30% local sweet corn and baby corn
 11.66% watermelons
 11.45% pumpkins
 6.06% vegetables
 5.47% dry season rice
 7.06% other crops

Traditional dry season crops are prone to radical fluctuations in production and area under cultivation. However, it appears that those crops with primarily only local market opportunities are less popular with farmers than previously was the case.

Price, Area Cultivated, Volume Produced
LNO Dry Season Crops 1981 - 1986

	1981/82	1983/84	1985/86
<hr/>			
Groundnuts			
Price (B/kilo)	8.00	9.17	5.78
Area (rai)	1741	7348	1336
Production (tons)	340	1199	221
Watermelons			
Price (B/kilo)	1.63	1.19	1.16
Area (rai)	1057	837	557
Production (tons)	2259	1900	872
Pumpkins			
Price (B/kilo)	1.04	1.21	1.58
area (rai)	1007	380	358
Production (tons)	4299	380	360

Source: LNO Operations Center

6.5.2 Industrial Food Crops

During the period of the project several pilot attempts were made to introduce industrial food crops (young ear corn and tomatoes) to the LNO area. Both of these crops had identified markets - processing factories in Sakon Nakhorn and Khon Kaen. These efforts were well supported by the LNO management, which in each case provided transport, manpower, and other facilities to underscore the feasibility (viability) of the effort and maintain farmer confidence that the potential existed for the further development of industrial crop production.

These initial efforts faltered for two basic reasons: 1) the farmer's lack of expertise in the production of a crop which demanded strict specifications; and, 2) the farmer's lack of experience and capability to harvest and properly handle (post-harvest technology) large volumes of perishable vegetable crops. These efforts also showed clearly that mere extension and even the presence of guaranteed markets cannot insure the successful cultivation of these crops by farmers, and thus they contributed to increasing the degree of acceptance of the managed production of irrigated dry season crops for sale to agro-industrial outlets.

Markets for industrial food crops capable of being produced at LNO are sizeable. Based upon discussions with DOA personnel at LNO and food processing and processed foods

marketing specialists at Kasetart University, the following industrial food crops have a high potential at LNO:

- Young ear corn (baby corn)
- Asparagus
- Sweet corn
- Young cucumbers (gherkins)
- String beans
- Peas

Four food processing factories are operating in the upper Northeast, while a fifth in Khon Kaen has ceased operations due to debt and management problems. Factory managers report that there is a shortage of high quality raw materials for processing, especially in the early and late dry season. During these periods these factories transport raw materials from Lampang and Chiang Mai in order to maintain operations. A pilot canning factory in Sakon Nakorn, originally built under Royal sponsorship, has recently been upgraded with assistance from a multi-national food processing firm, which will also help to improve management and quality control procedures. It was reported that if this factory can be made to produce canned tomato paste at full capacity, the same multi-national firm would consider building another factory in the same area. The production of this factory is aimed at the export market. However, the domestic market demand for tomato paste exceeds local supply by 30-35%. The Thai canned sardine industry alone consumes approximately 6,482.5 tons of tomato paste annually. However, because of the frequently unsatisfactory quality of domestic paste it must import a large portion of the paste it uses.

Although all four factories process tomatoes for paste almost exclusively, the managers claim that they are also interested in several other crops for processing including: young ear corn (baby corn), asparagus, beans, sweet corn, pineapple, and peas. Each factory requires minimum quantities of each crop before it would be worthwhile to adapt equipment to different crops. That minimum quantity depends on the capacity of each factory; varying from 5 to 15 tons per day.

The proximity of Lam Nam Oon to the four operational processing factories gives it a locational advantage over other irrigation command areas of the Northeast. However, it will be necessary to substantially improve the quality of the industrial food crops grown at LNO, if it is to turn this natural advantage into increased income for the residents of the area.

Studies financed by USAID in 1982 and 1983 reported on the types of crops and market share Thailand could claim of the processed food markets in Hong Kong, Japan, Singapore and the United States. Lam Nam Oon could easily contribute to Thailand's claim on those markets.

Any significant expansion of industrial food crop production at LNO would probably serve as an incentive for the Kaset Isan Company (Khun Chatchai Boonyarath), which also owns the 10,000 rai Tawan Farm in nearby Seka district of Nongkhai, to pursue its planned investment in a 700 MT/day processing factory. This very large facility has been planned for establishment in

Phananikhom district of Sakon Nakhorn province. The chairman of the company pointed out that the Tawan Farm would serve as his firm's fallback supply of tomatoes, while a significant supply of raw materials for processing would be expected from the LNO Project area.

Although the Kaset Isan factory is still in the planning stage, the LNO Project staff should continue research on industrial food crops and techniques of managed production to meet possible future demand. The excess capacity which exists in operational processing facilities is sufficient enough reason to promote the production of industrial food crops.

6.5.3 Vegetable Crops

Vegetables traded in the five markets serving the Lam Nam Oon area are obtained from three principal sources: areas of intensive vegetable production near Phangkhon; in Sakon Nakhorn; and, through middlemen who transport vegetables into the Lam Nam Oon area from other provinces.

The peak production period for vegetables in the LNO area is during the cool season, December through February. Quantities not consumed by the household or traded in the village will be shipped to central markets. During this time only specialty vegetables are shipped into local markets from Bangkok and other central markets in the Northeast.

Beginning in mid-March, however, local vegetable production decreases, prices begin to climb, and the volume of vegetables transported into the area begins to increase. Thus, vegetables are brought into the Lam Nam Oon markets from mid-March until October or November.

Vendors reported buying vegetables from local producers as well as from middlemen who transported vegetables to Sakon Nakhon from other provinces. Although the vendors preferred to purchase locally produced vegetables, supplies were inconsistent and quality was generally lower than that sold by middlemen. The issue of product quality appears to be one of the most important obstacles to successful market penetration by LNO farmers.

6.4 Grain crops

The potential for the expansion of production and marketing of rice is severely limited at LNO. Rice continues to be the principal wet season crop at Lam Nam Oon. An estimated 154,300 rai, or 96.26% of the irrigated area of Lam Nam Oon is planted in rice during the wet season. During the 1985 wet season, 54,500 rai was cultivated employing water from the right main canal (RMC), and 99,800 rai using water from the left main canal (LMC).

Certain indicators point to adjustments which have taken place in the wet season cropping patterns. Farmers have generally accepted improved rice seed varieties being promoted by

the Government over native varieties. An estimated 95% are planting improved varieties. A second indicator is the fact that farmers participating in the dry season managed tomato and vegetable seed production programs have been required to plant their rice crop earlier. These farmers plant a non-photosensitive variety of non-glutinous rice in early June for harvest in October, thus freeing those areas for the planting of other crops during the earliest part of the dry season.

Dry season rice is discouraged because it requires a great deal of water which could be better used for upland crops, and because dry season rice tends to have an excessively high moisture content due to harvesting during the early monsoon rains. Furthermore, LNO, not being a traditional producer of dry season rice, would be at a disadvantage in that the Nong Wai Irrigation Project in Khon Kaen has considerably more experience in dry season rice production than does LNO. Marketing channels and structures are in place, providing Nong Wai with a marketing advantage.

Although wheat is being tested at Sakon Nakhorn by the DOA, the crop is new to farmer-irrigators as well as to agriculture field personal, and thus at a disadvantage. The potential does exist in the long-term for LNO to produce a sufficient quantity of wheat so as to make processing worthwhile. One agro-business firm operating in the LNO area is now testing several varieties of wheat. If the results of the initial 1985/86 trail are satisfactory, it plans to undertake full-scale

testing during the 1986/87 dry season. However, at the moment no production or agro-industrial infrastructure exists to support a large scale wheat production program. Variety trials and testing should be encouraged, however, while private sector traders are sought to purchase wheat from LNO. Over the longer term, LNO may be able to claim a share of the market for wheat, which is now being imported in significantly larger quantities.

6.6 Seed Crops

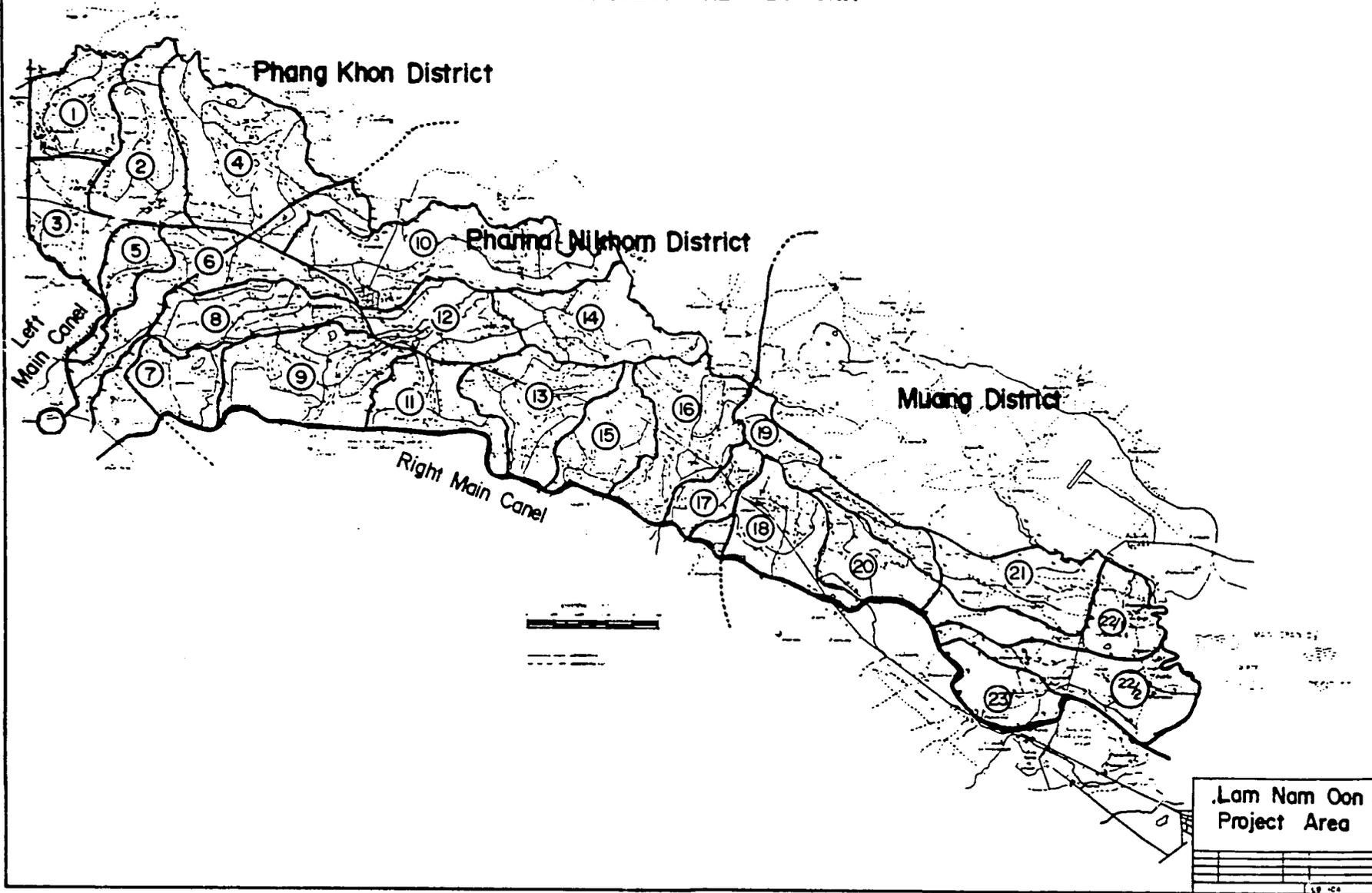
The seed crops now being produced at LNO - tomatoes, peas, white radish - are for export markets. The cantalope seed is for shipment to Chiang Mai, where cantalopes have been successfully grown for sale in the Bangkok market. The two firms managing seed production activities have had considerable experience in producing and marketing vegetable seeds from Thailand. Depending on the results of the trials underway at LNO during the 1985/86 dry season, these firms could serve as a link to overseas outlets for an expansion of seed production activities at LNO.

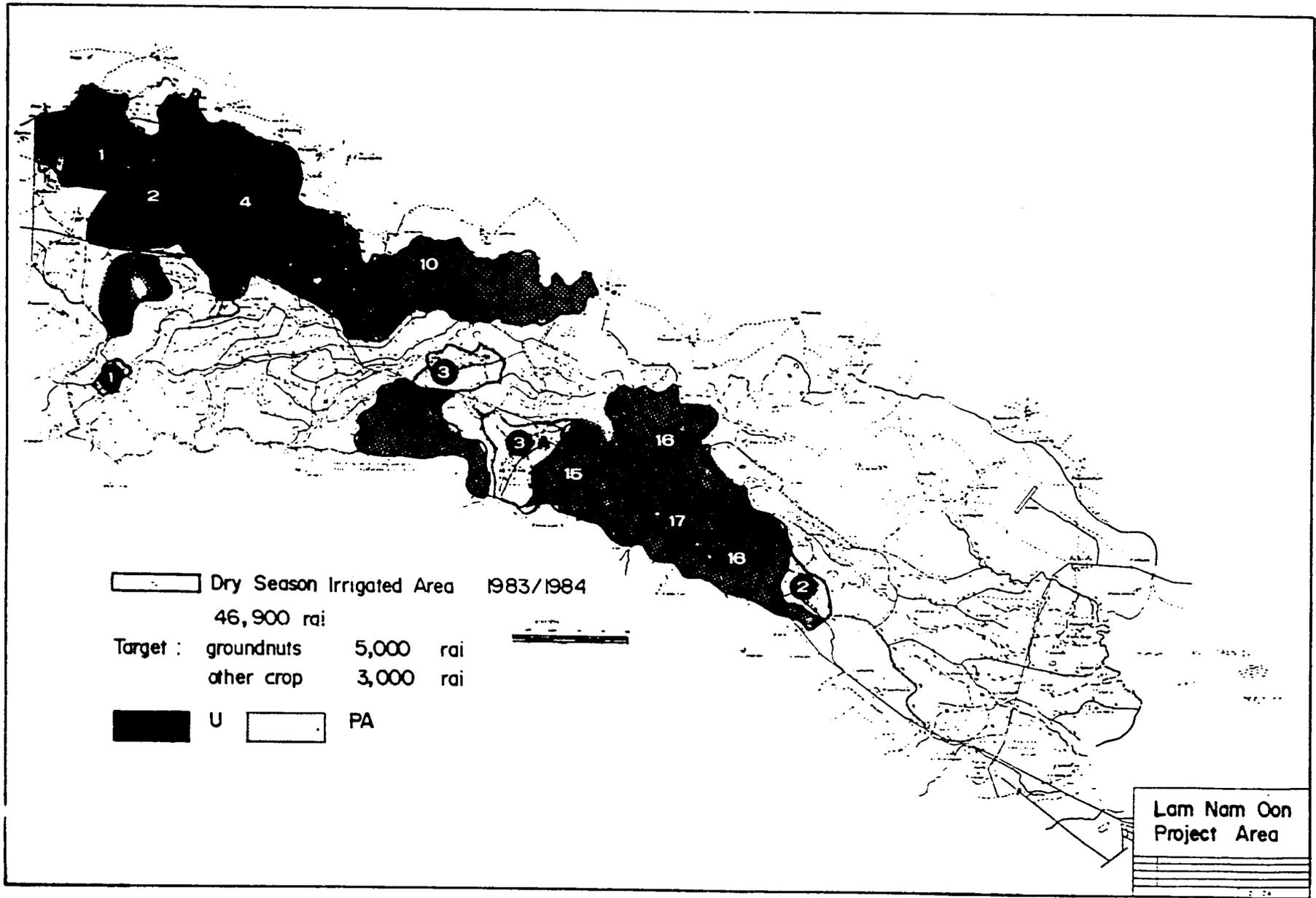
The high prices received by farmers for seed - 1,000 baht/kg. for tomatoes and 700 baht/kg. for cantalope - make the cultivation of seed crops a potentially high money earner for LNO farmer irrigators.

ATTACHMENT A

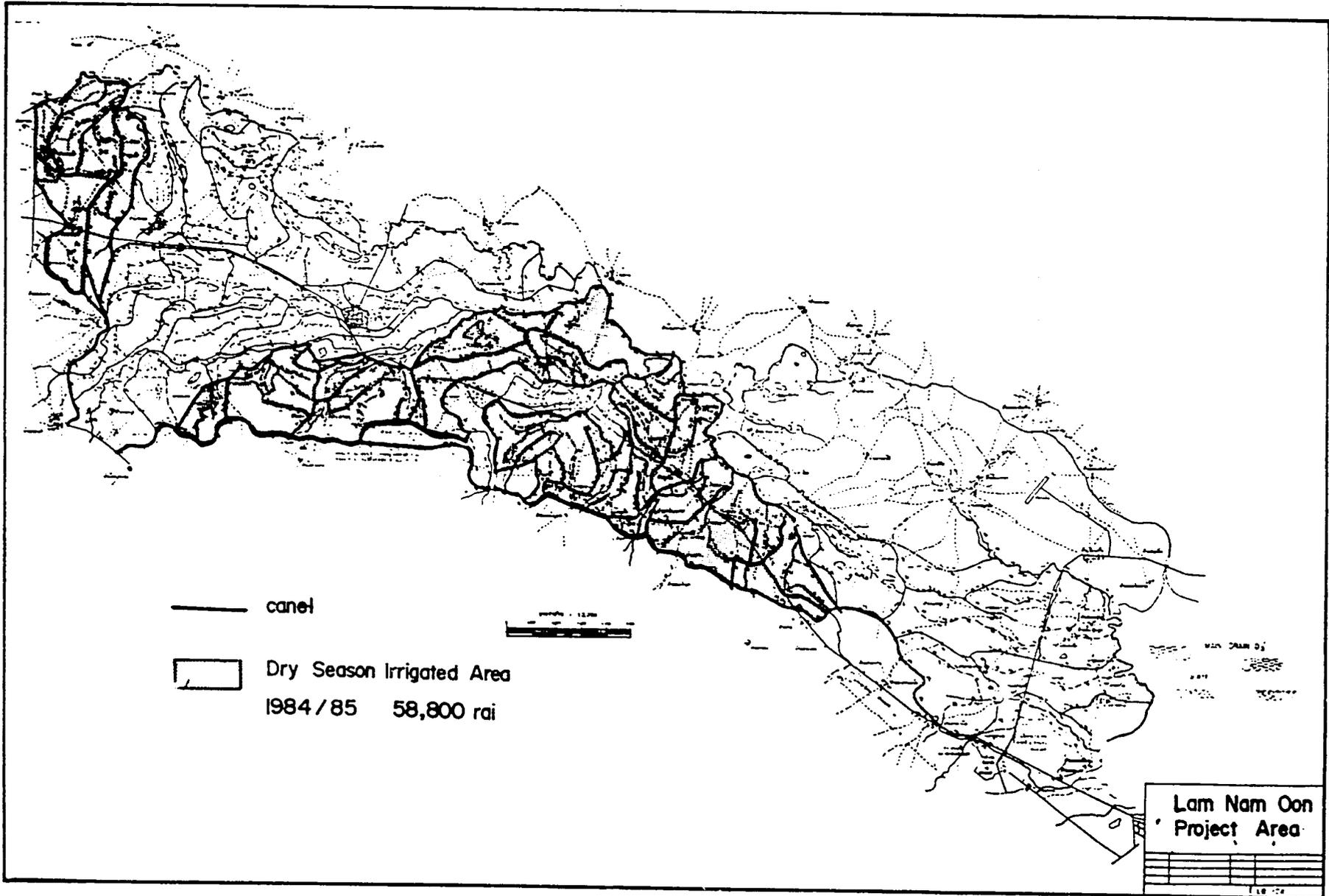
MAPS OF THE LAM NAM OON PROJECT AREA

PROJECT AREA BY UNIT

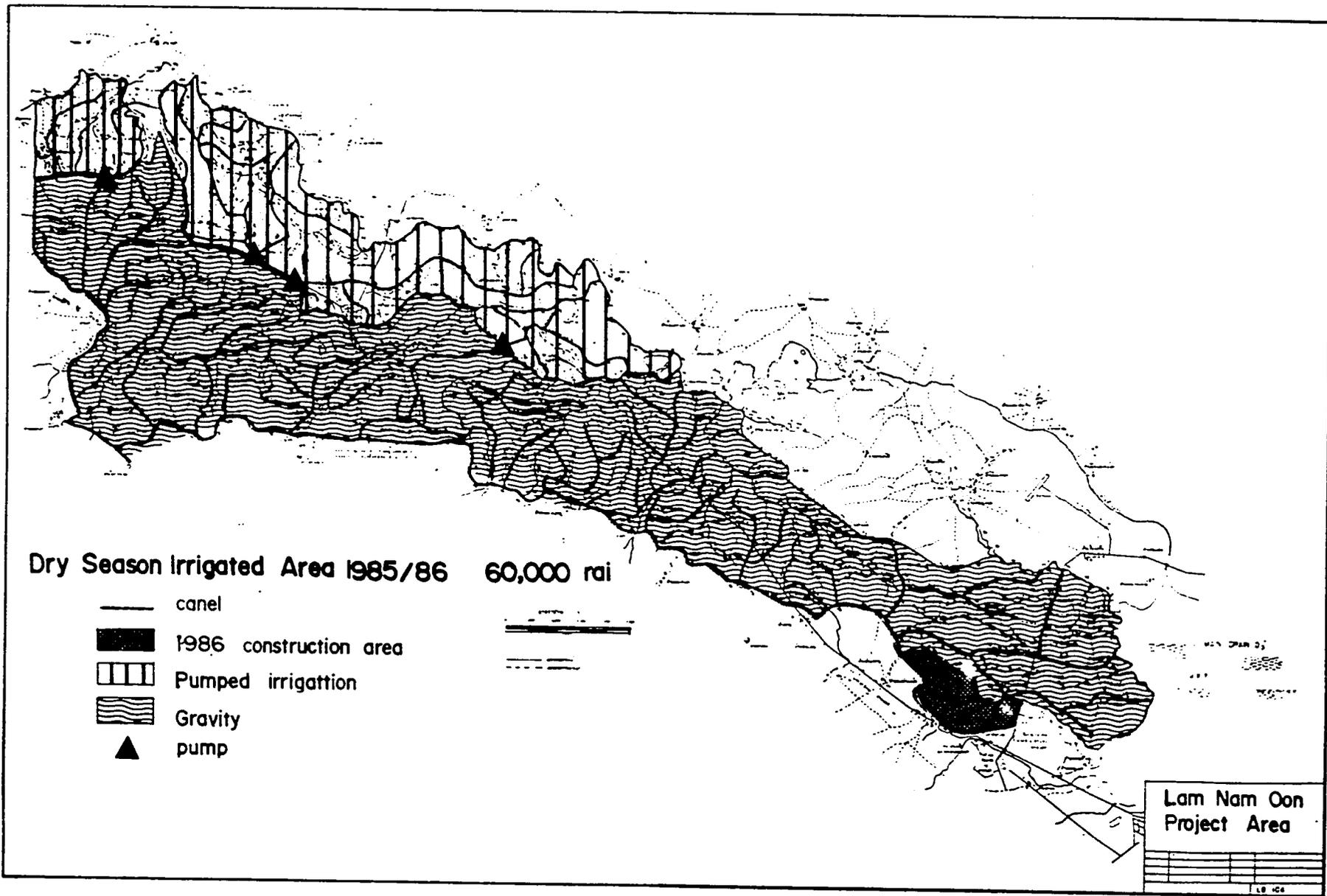




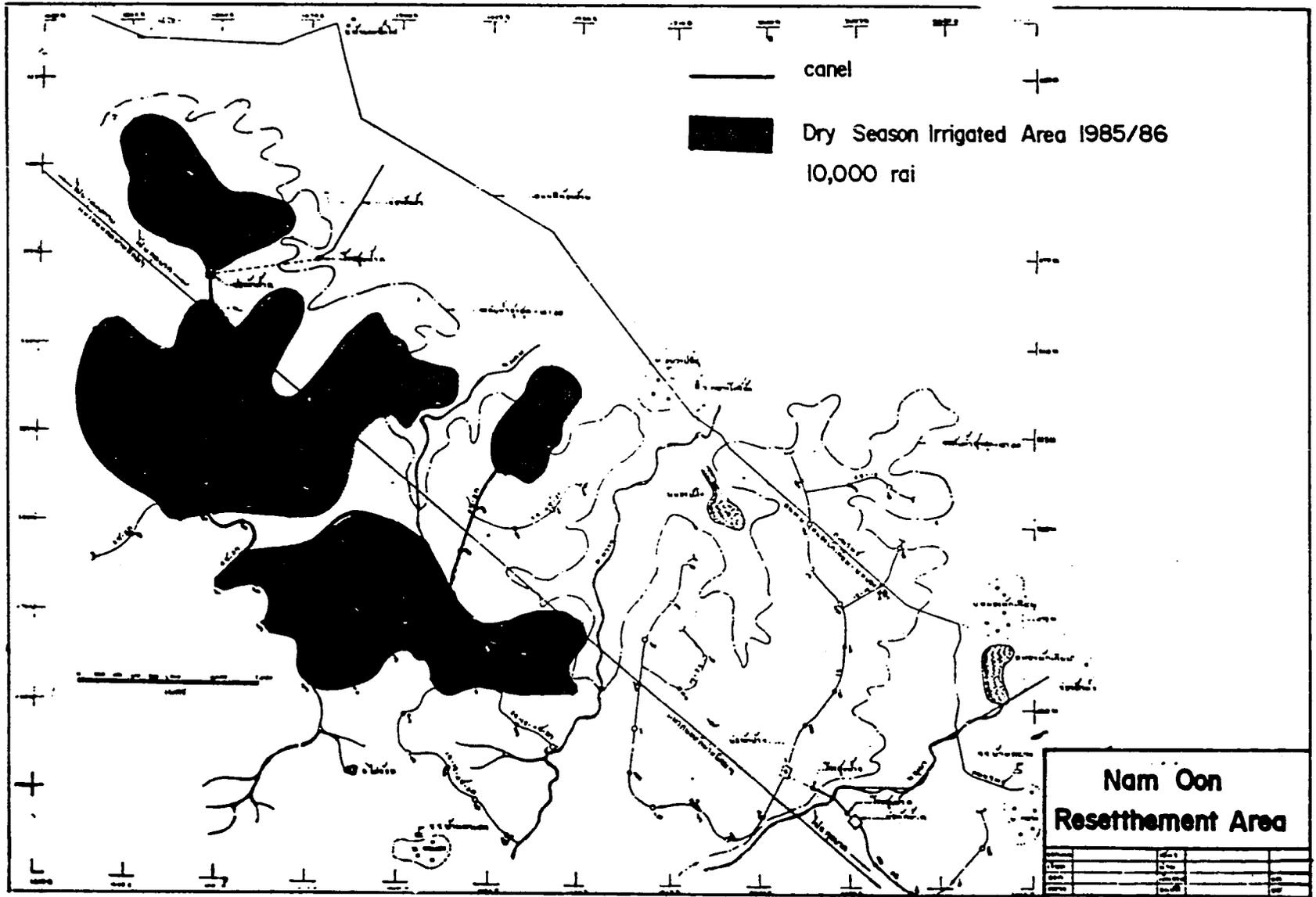
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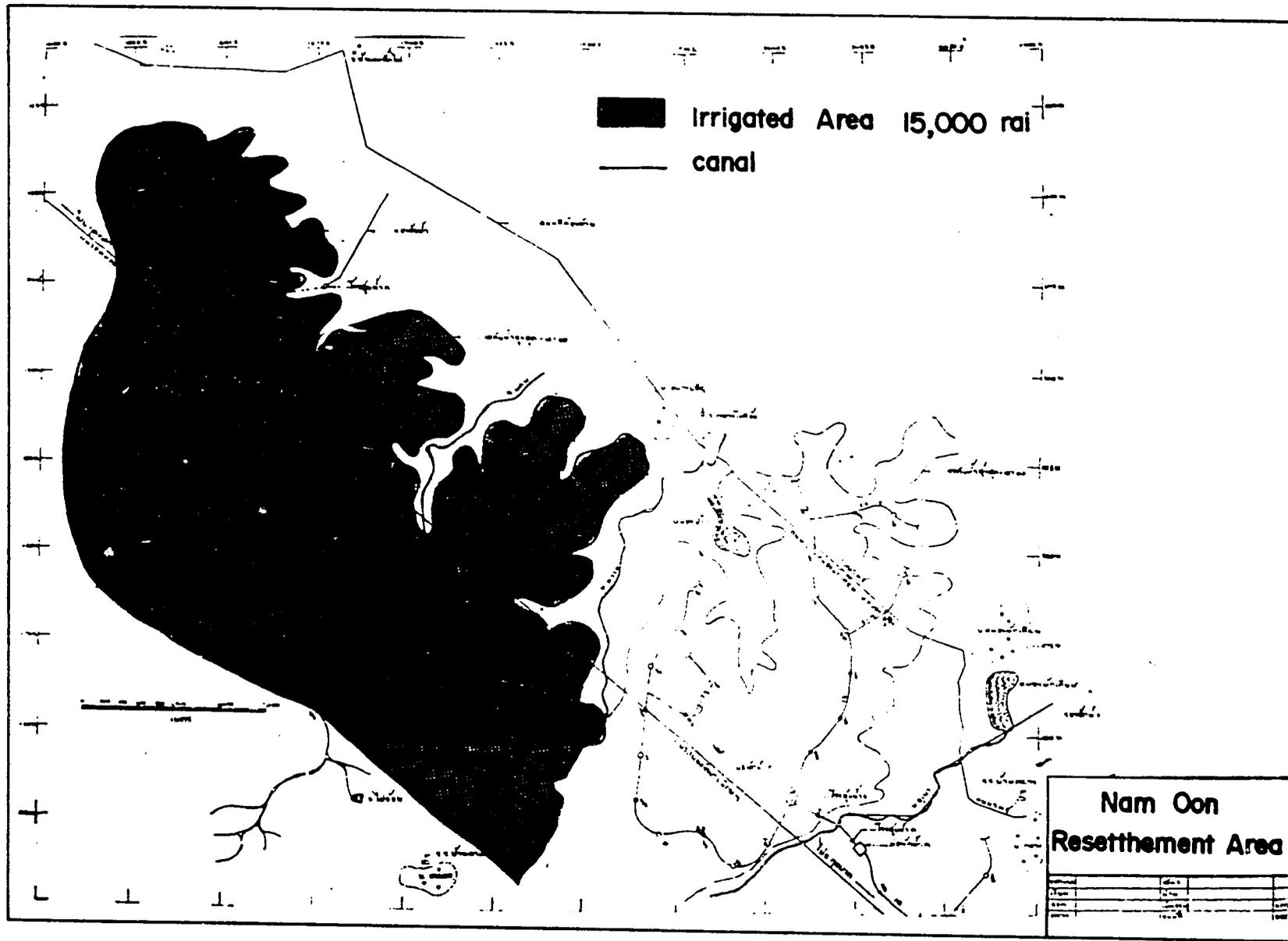


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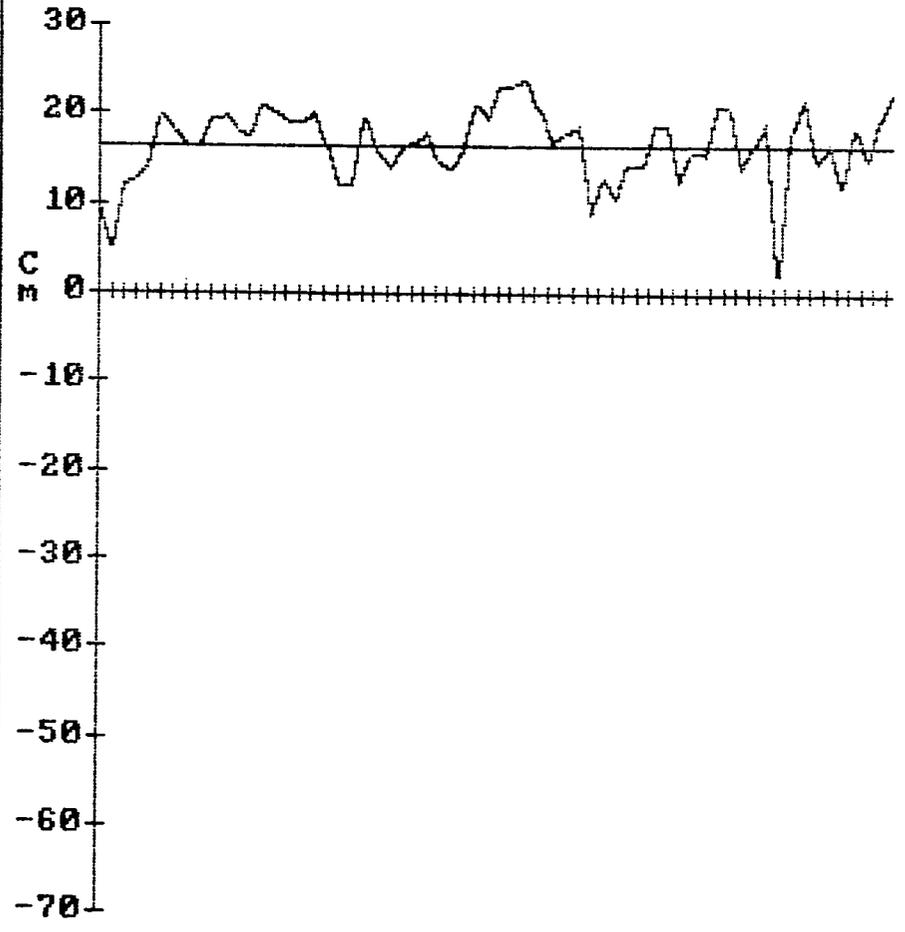




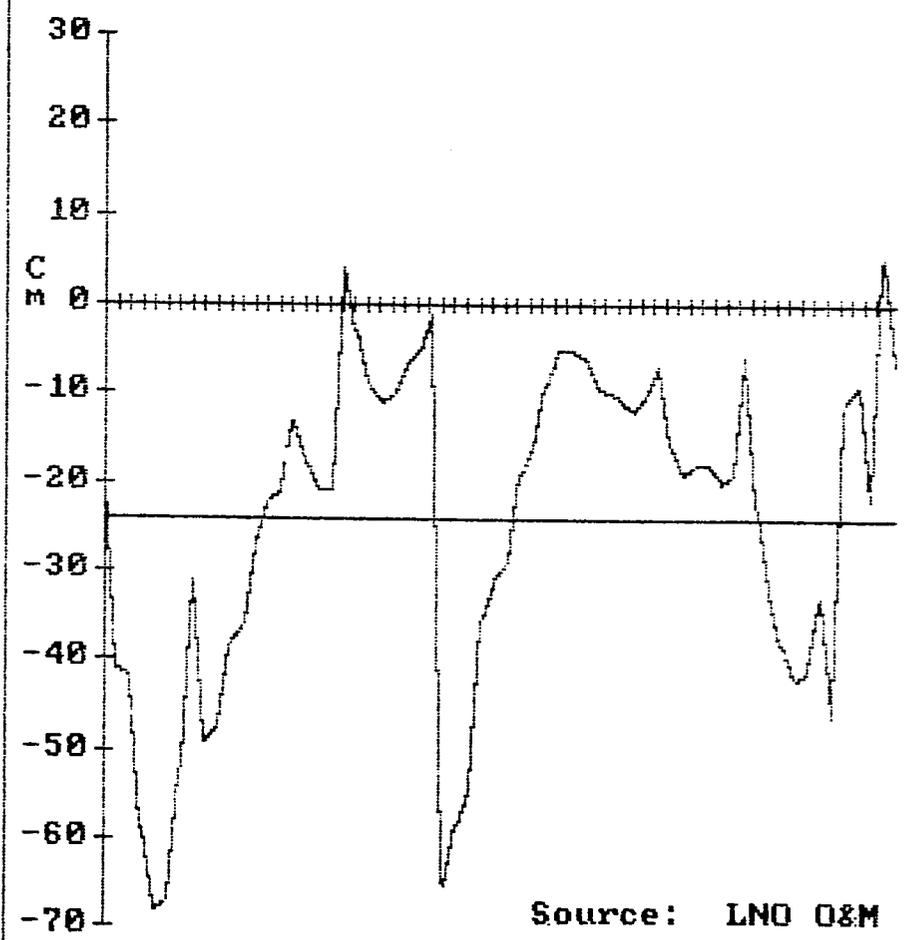
ATTACHMENT B

**WATER LEVEL CHARTS - RIGHT MAIN CANAL
1983/84 and 1985/86**

Chaek 4 Water Level
1/3/83 to 3/8/83

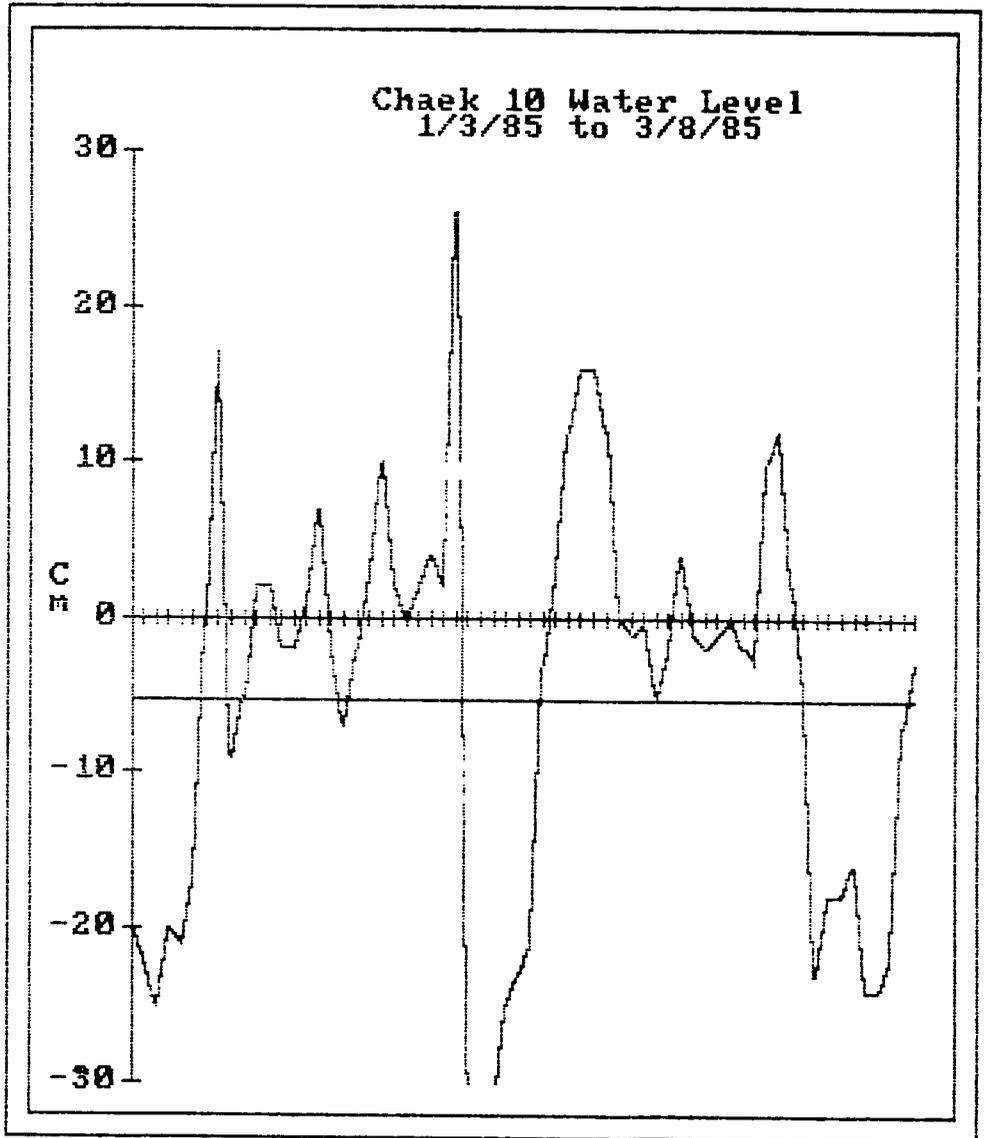
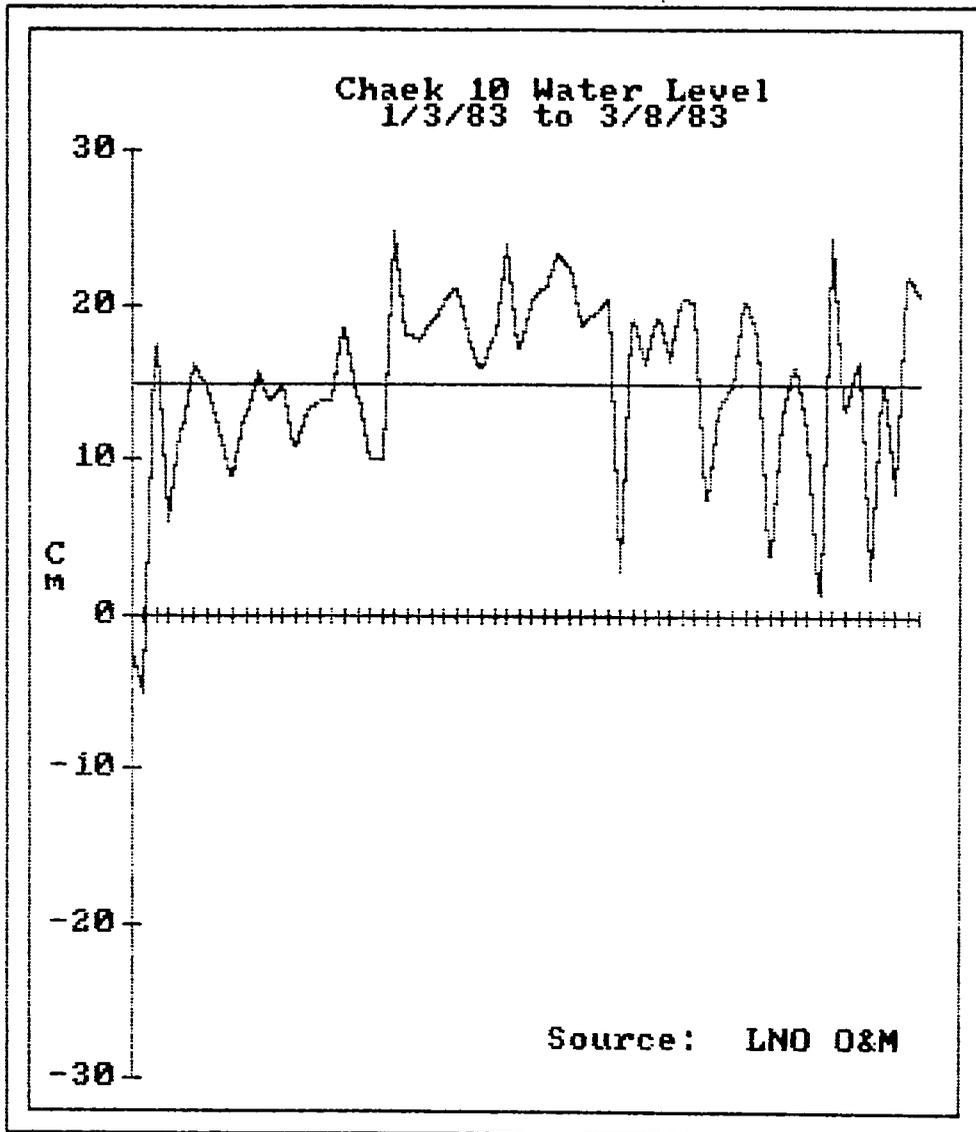


Chaek 4 Water Level
1/3/85 to 3/8/85

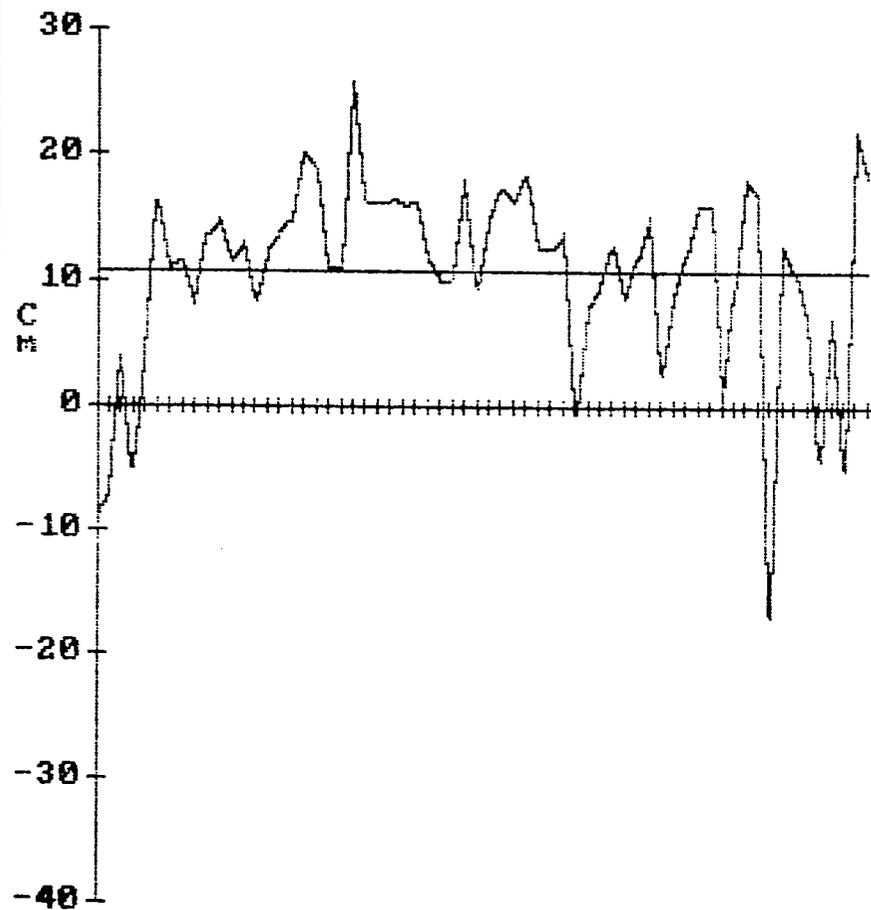


Source: LNO O&M

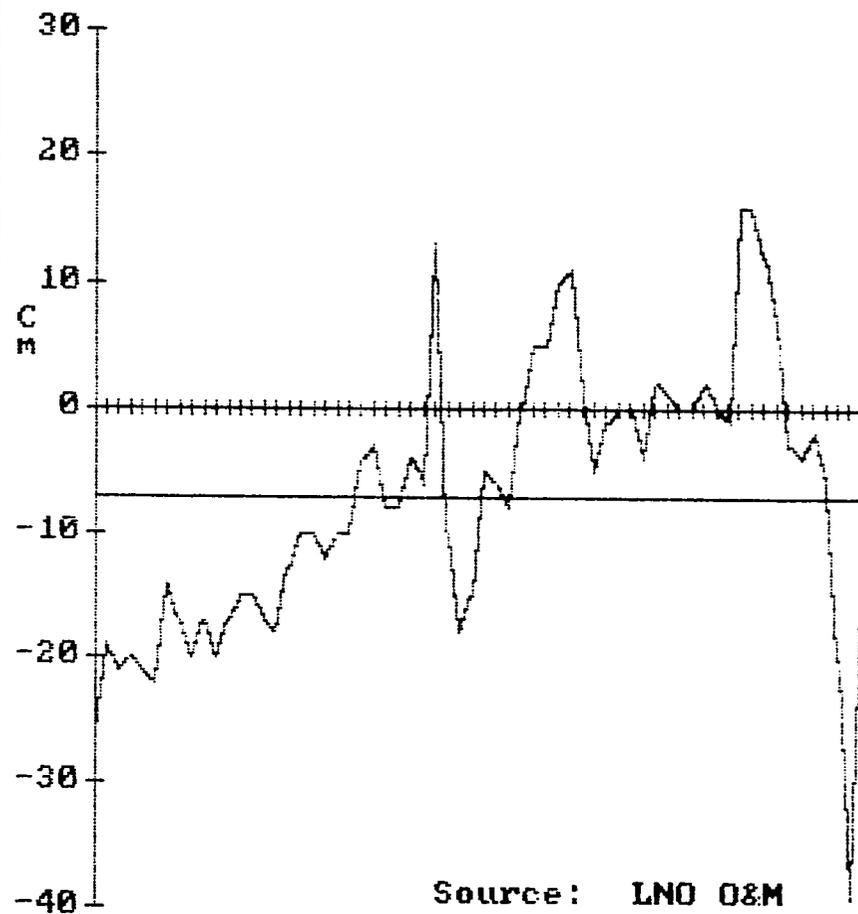
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Chack 14 Water Level
1/3/83 to 3/8/83

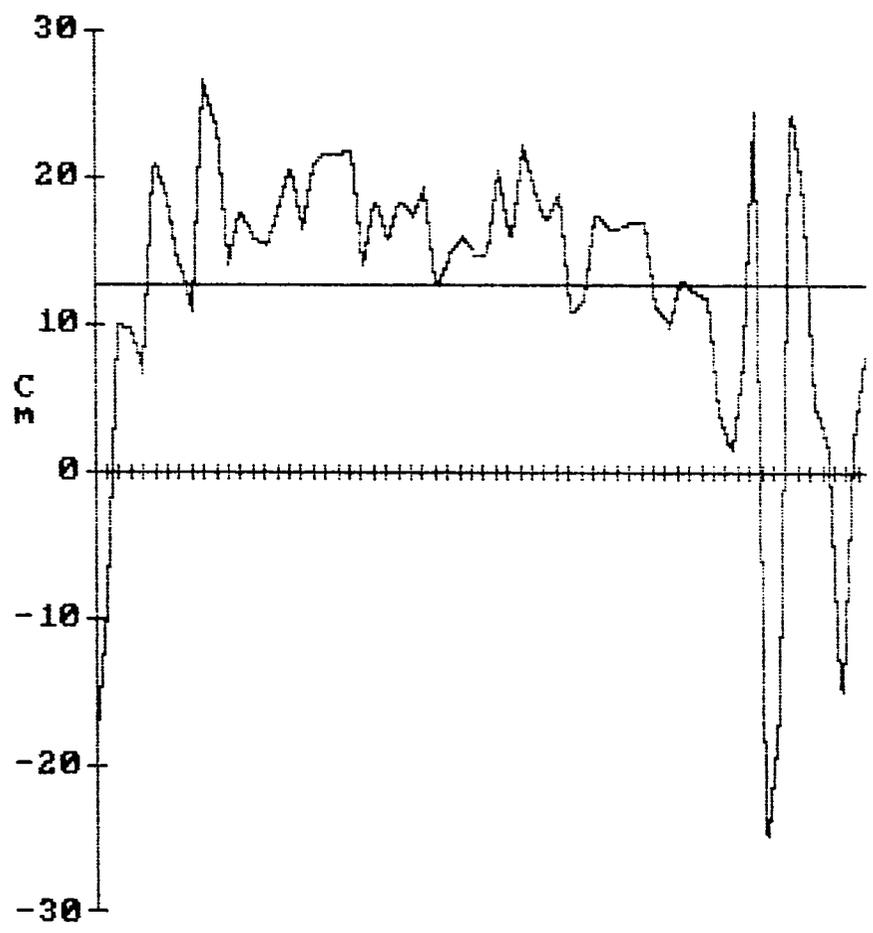


Chack 14 Water Level
1/3/85 to 3/8/85

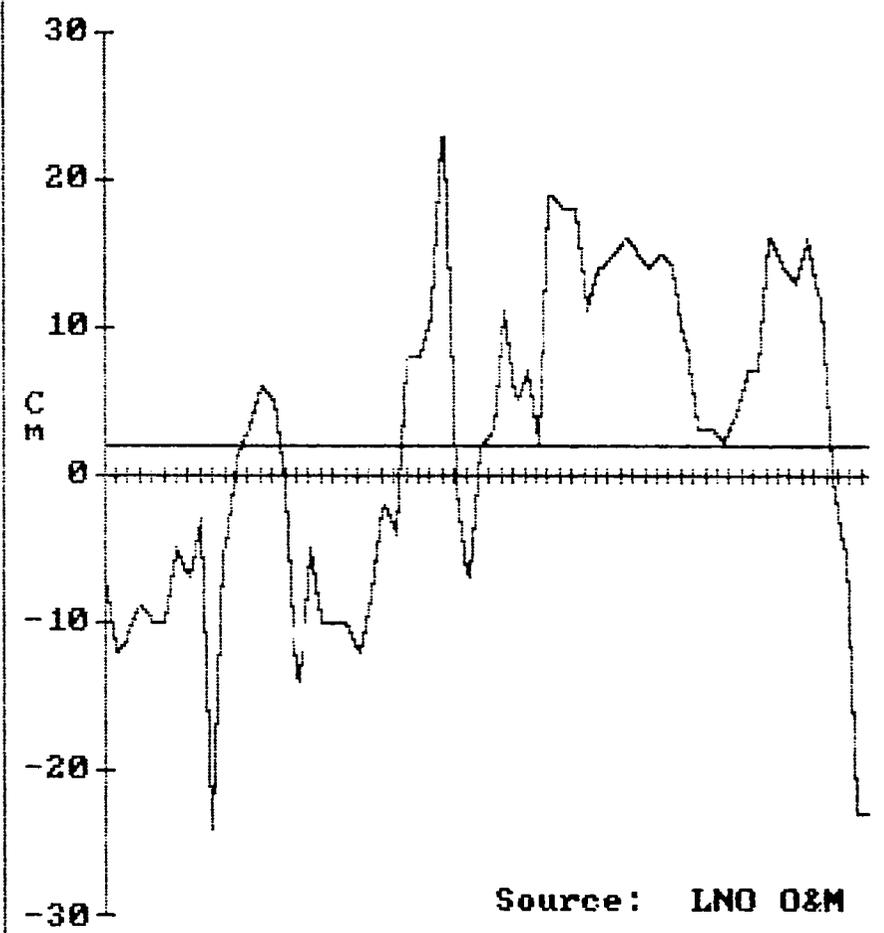


Source: LNO O&M

Chaek 22 Water Level
1/3/83 to 3/8/83



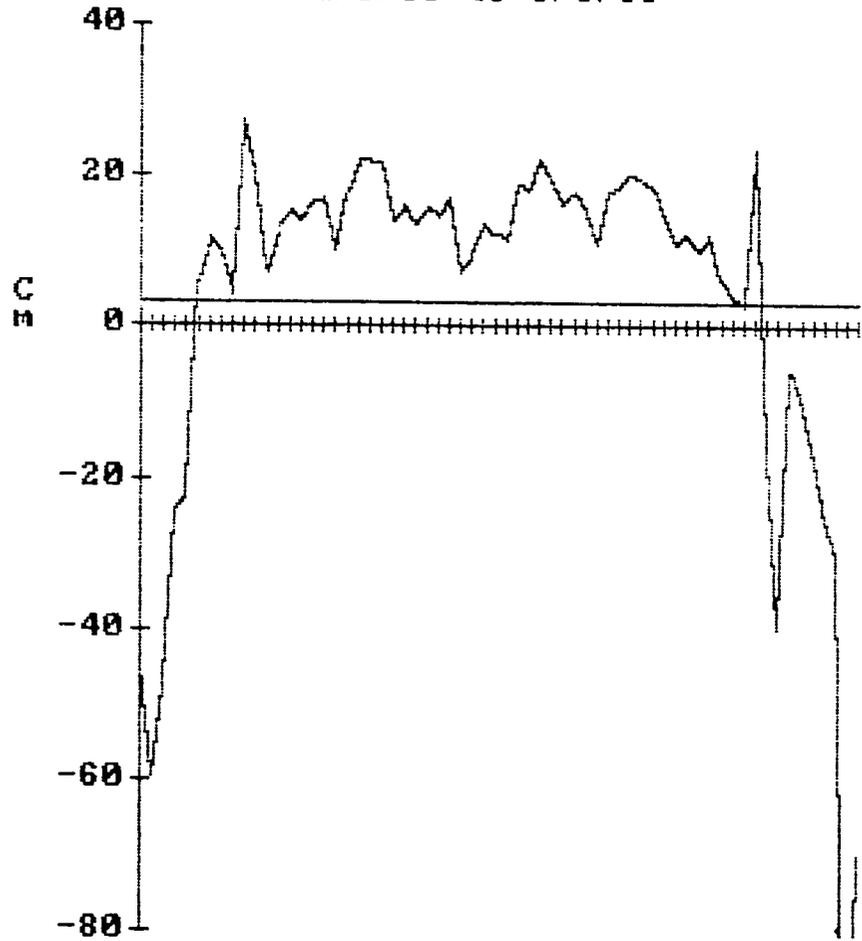
Chaek 22 Water Level
1/3/85 to 3/9/85



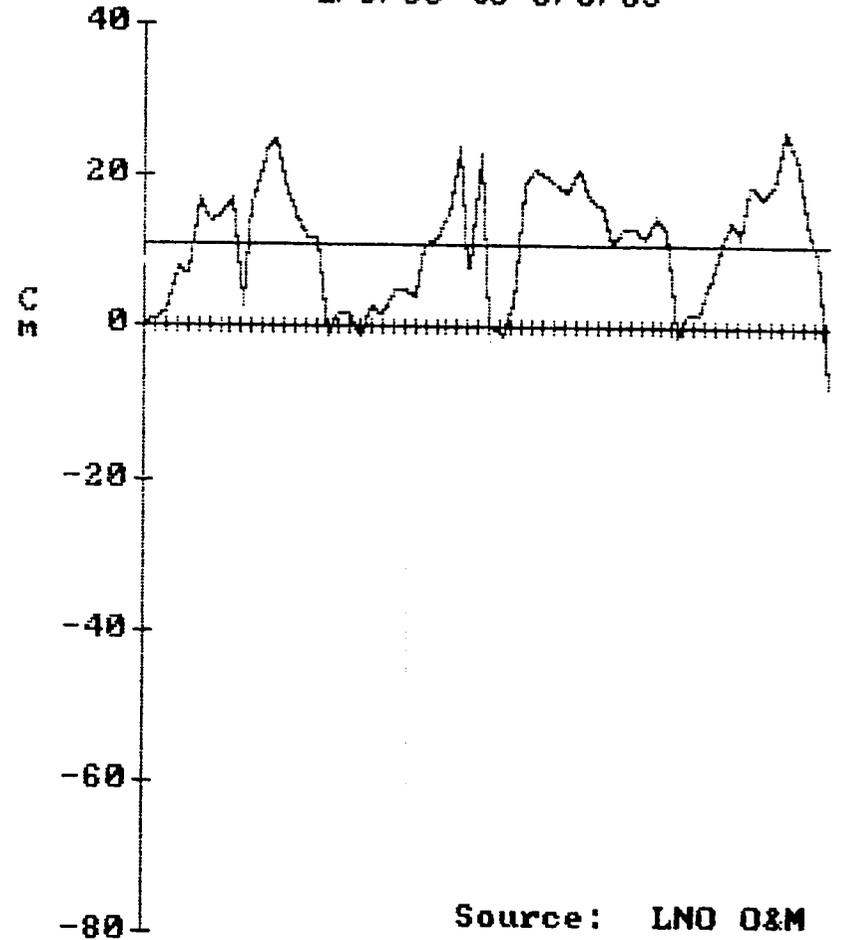
Source: LNO O&M

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Chaek 26 Water Level
1/3/83 to 3/8/83



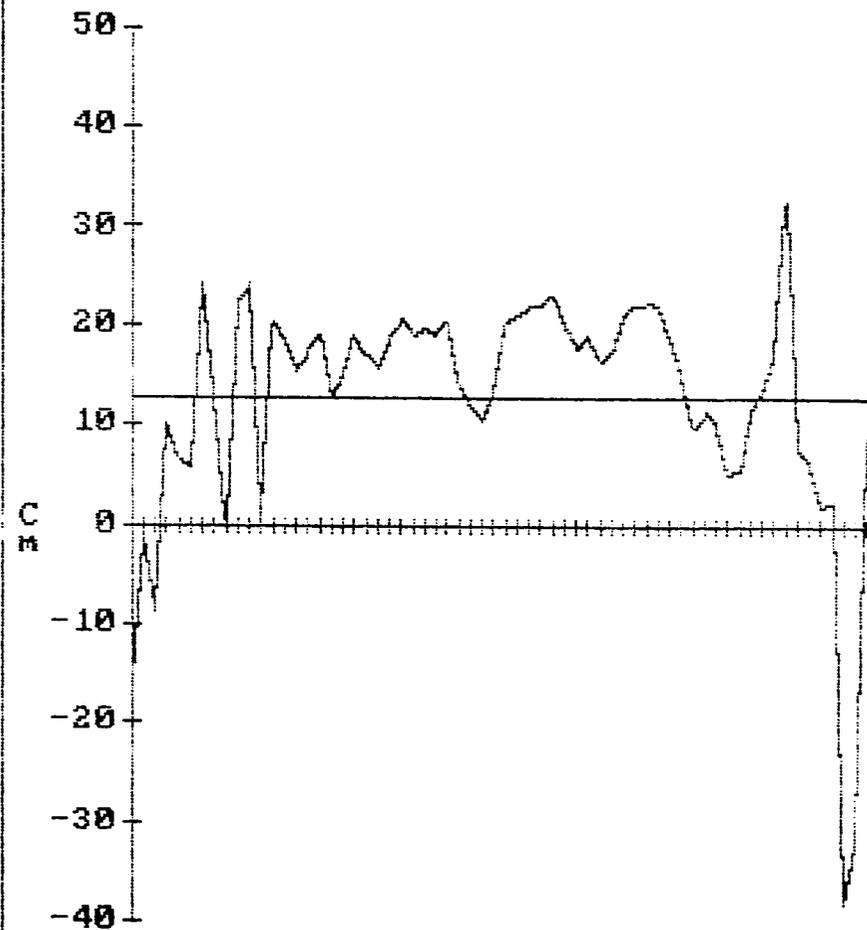
Chaek 26 Water Level
1/3/85 to 3/8/85



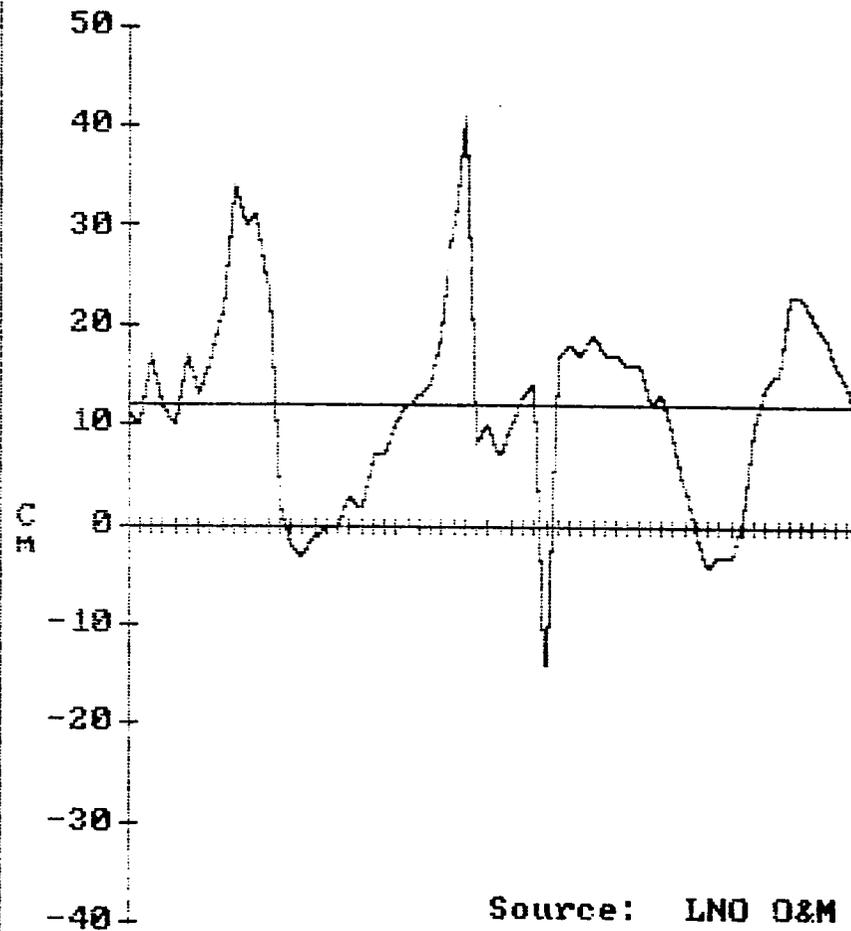
Source: LNO O&M

125

Chaek 31 Water Level
1/3/83 to 3/8/83

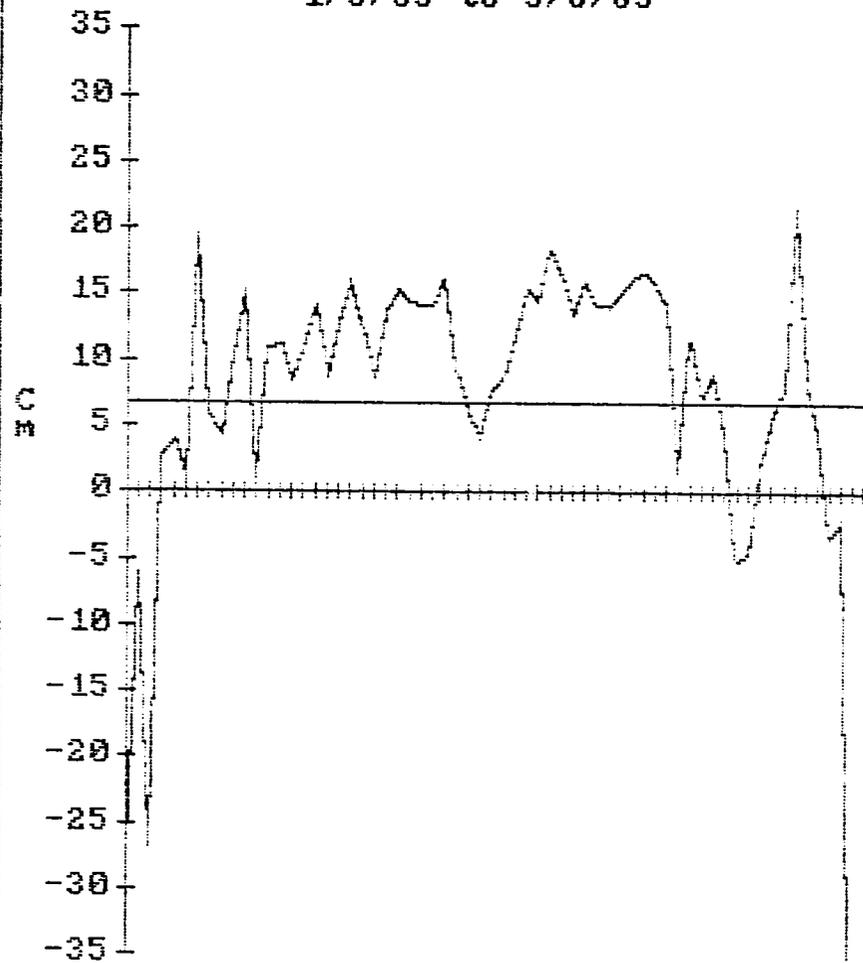


Chaek 31 Water Level
1/3/85 to 3/8/85

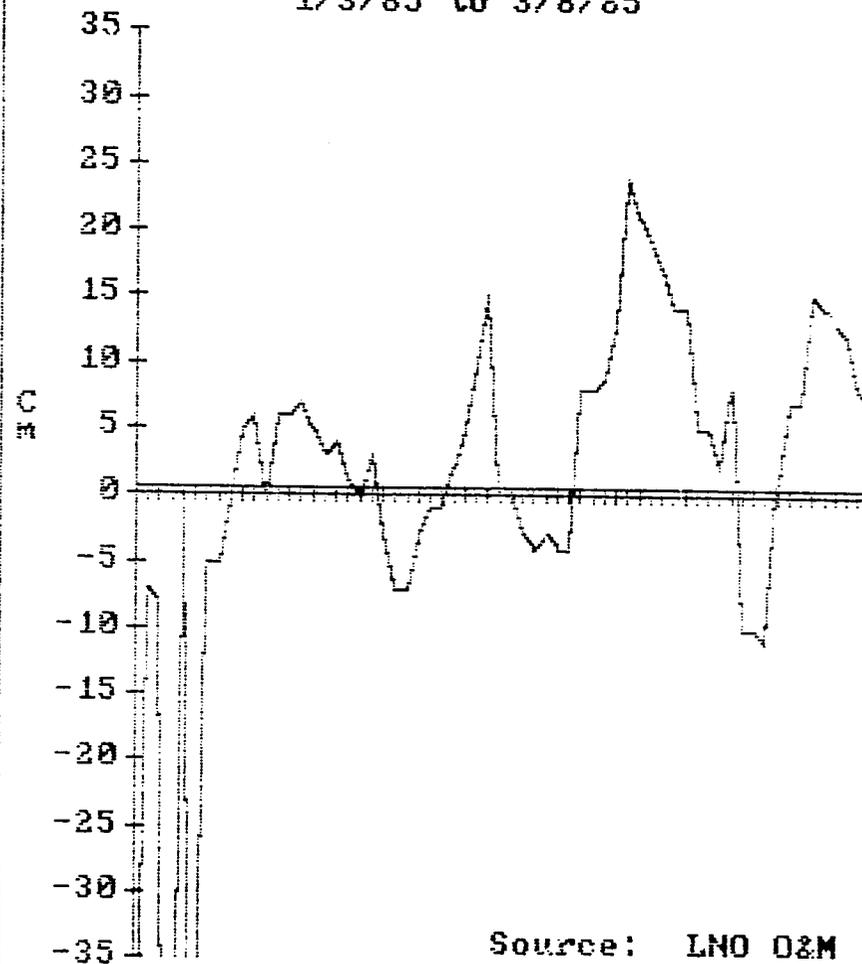


Source: LNO O&M

Chaek 33 Water Level
1/3/83 to 3/8/83

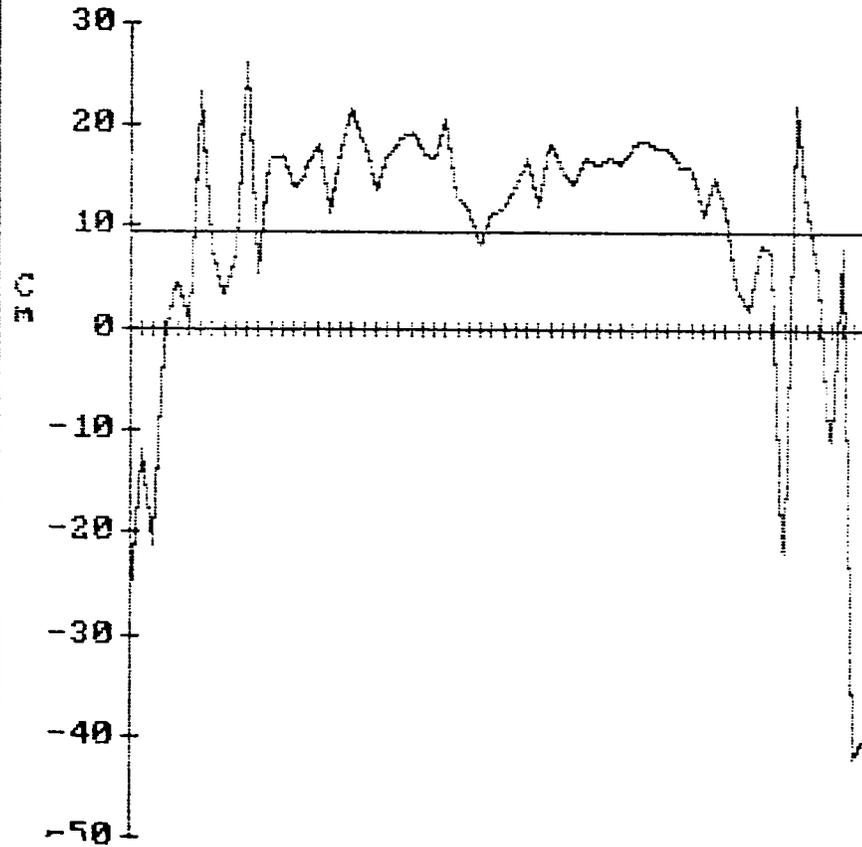


Chaek 33 Water Level
1/3/85 to 3/8/85

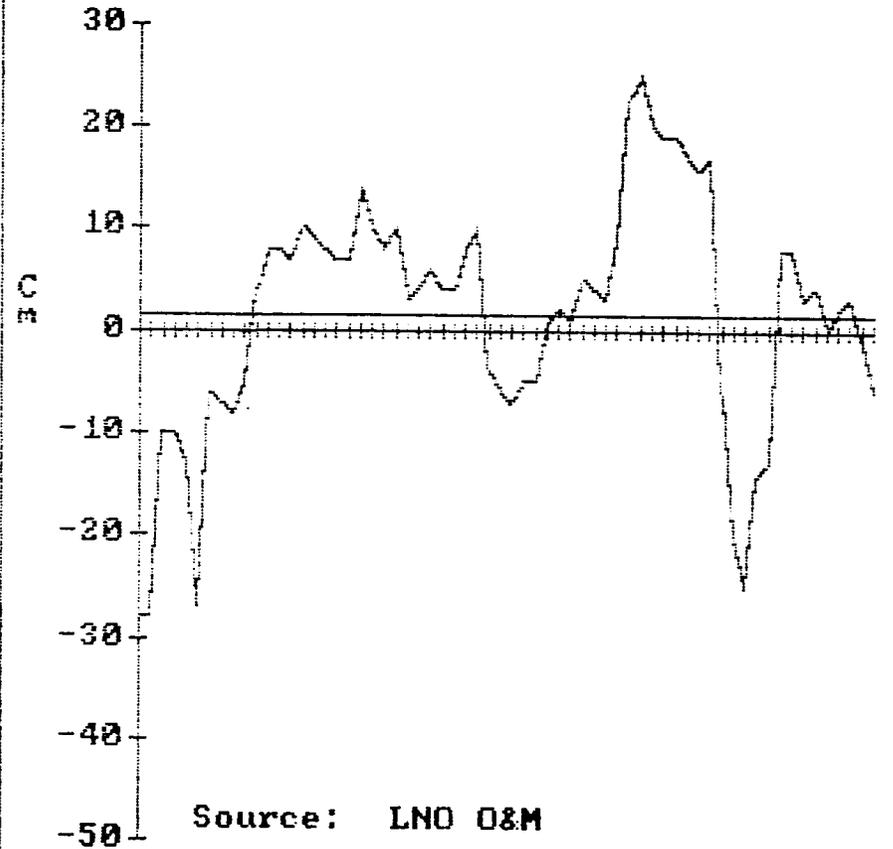


Source: LNO O&M

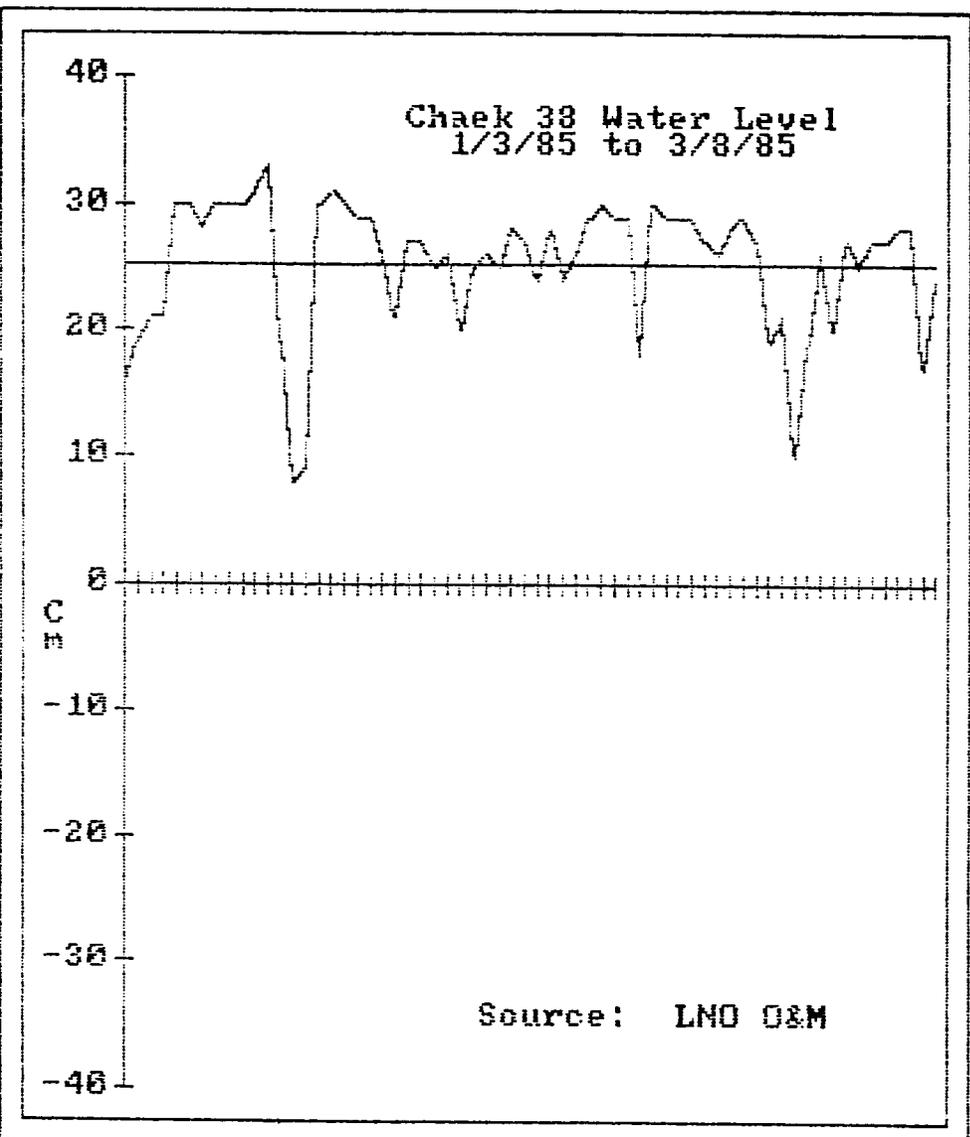
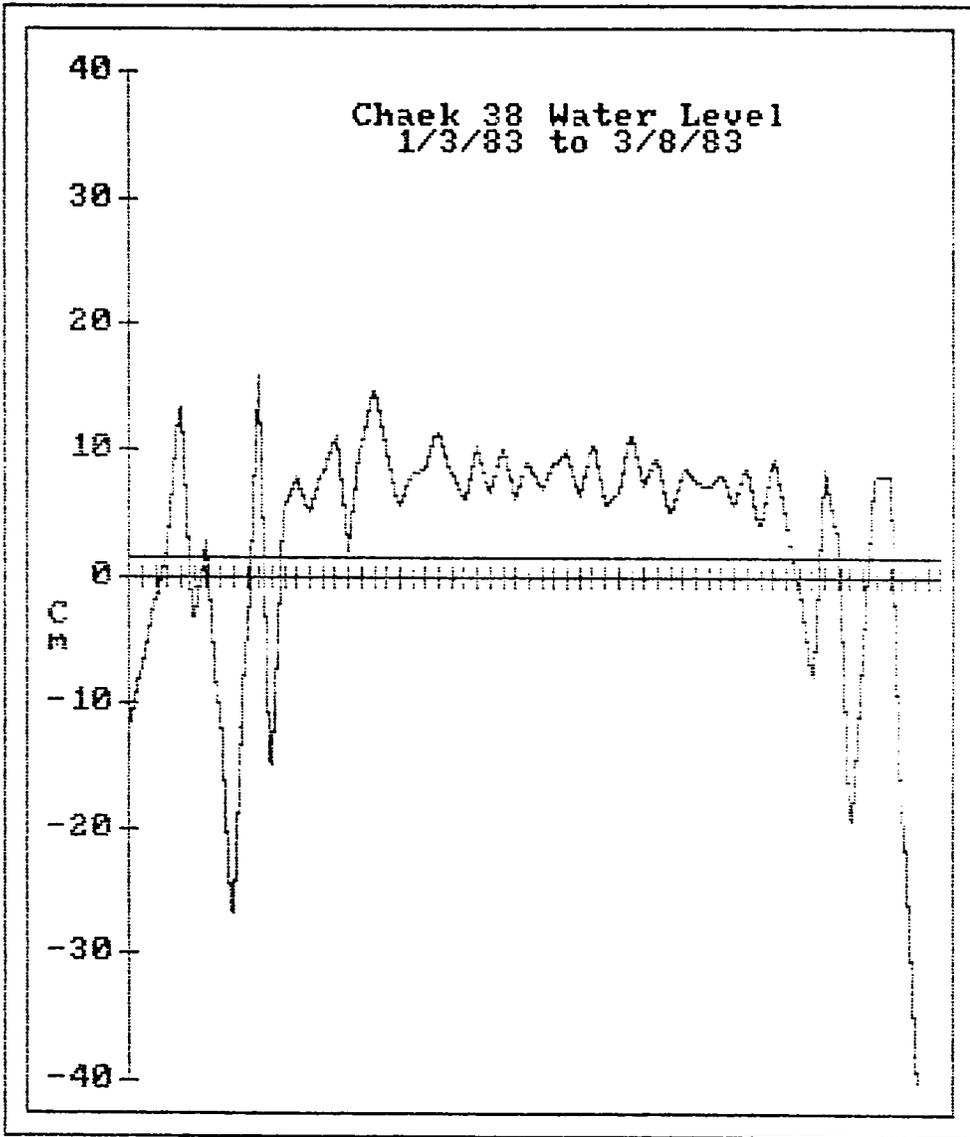
Chaek 35 Water Level
1/3/83 to 3/8/83



Chaek 35 Water Level
1/3/85 to 3/8/85



Source: LNO O&M



ATTACHMENT C

TABLES FOR SECTION 5.0 REVIEW OF ECONOMIC BENEFITS

Table 1
Net Financial and Economic Returns of Crops
(1985 Baht/rai)

	Total Cost		Yield Per Rai (Kg/rai)	Farm-Gate Price (B/kg)	Net Revenue	
	Fin.	Econ.			Fin.	Econ.
1. Non-glutinous rice	576.10	506.61	500.00	1,500	973.90	1,043.90
2. Peanuts	1,383.60	1,161.60	250.00	9.59*	1,013.89	1,235.90
3. Water melon	917.16	766.48	1,565.93	1.16	899.32	1,050.00
4. Pumpkin	880.66	739.71	1,005.91	1.58	125.25	849.63
5. Sweetcorn	1,168.27	981.63	2,583.50**	0.67	562.67	749.31
6. Baby corn	1,386.77	1,165.47	826.51	1.97	241.69	462.99
7. Tomatoes	2,569.30	2,159.98	2,771.22	1.44	1,421.26	1,830.58
8. Chillies	2,279.46	1,907.63	349.29	11.07	1,587.21	1,959.04
9. Vegetables	1,734.50	1,492.49	474.50	5.50	875.25	1,117.26

Note: *The market price in 1984/85 crop year should be between 7.00 baht to 6.50 baht. However in view of the past price trend, as well as the OAE's estimate, the high farm-gate price of 9.59 is used in the present analysis.

** Ears Yield/rai

Table 2
Instability Indices of the Bangkok Market Prices.

	Instability Indices		Instability Indices
1. Paddy grade 2 100%	8.02888	18. Groundnuts (shelled)	2.90713
2. Paddy 5%	8.00966	19. Buffaloes	2.81760
3. Paddy grade 3 100%	7.99442	20. Garlic	2.35619
4. Ginger	6.32431	21. Onions	2.23796
5. Silk grade 1	6.17740	22. White little tunny	2.34920
6. Gherknins	4.89947	23. Tomatoes	2.20430
7. Non-glutinour rice 10%	4.86706	24. Soybean (Swan)	2.08307
8. Black Mung bean	3.64000	25. String bean	2.05188
9. Snakehead fish	3.39560	26. Challots	1.85741
10. Ducks	3.32217	27. Redbean	1.85694
11. Cattle	3.31470	28. Long glutinous rice	1.74225
12. Black Pepper	3.25351	29. Short glutinous rice	1.71147
13. Black little tunny	3.17570	30. Non-glutinous rice 5%	1.56796
14. Catfish	3.14856	31. Tamarind	1.43960
15. Cotton	3.11887	32. Pumpkin	1.17158
16. Water melon	2.97041	33. Better melon	1.10856
17. Broilers	2.94070	34. Corn	1.06491

Note: The instability index is defined as:

$$I = \frac{\sum (\ln P_{t+1} - \ln P_t - k)}{(n-1)}$$

where

I = instability index
P = price,
n = total number of periods,
T = time

Source: OAE

Table 3a
Cropping Intensity

	Irrigable Area (rai)	Cropped Area		Dry Season (rai)	Cropping Intensity
		Total (rai)	Wet Season (rai)		
1976	185,800	167,400	167,200	200	0.901
1977	185,800	168,020	167,000	800	0.904
1978	185,800	178,533	167,220	11,313	0.961
1979	185,800	192,060	167,220	24,840	1.034
1980	185,800	187,277	167,220	20,057	1.008
1981	185,800	194,070	167,220	26,850	1.045
1982	185,800	173,990	167,220	6,770	0.936
1983	185,800	173,441	167,220	6,221	0.933
1984	185,800	176,902	167,220	9,682	0.952
1985	185,800	170,148	167,220	2,928	0.916
1986	185,800	182,220	167,220	15,000	0.981
1987	185,800	187,220	167,220	20,000	1.008
1988	185,800	197,220	167,220	30,000	1.061
1989	185,800	207,220	167,220	40,000	1.115
1990 and thereafter	185,800	217,220	167,220	50,000	1.169

Table 3 (b)
LND Cropping Pattern

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Non-Glutinous															
Rice	200	600	6,948	20,508	11,443	8,800	726	408	363	-	1,000	500	10,000	15,000	20,000
Peanut	-	50	411	500	3,452	9,500	1,760	2,393	7,348	1,336	5,000	6,000	7,000	8,500	10,000
Watermelon	-	-	-	-	-	-	1,055	370	837	557	1,000	1,250	1,500	1,750	2,000
Pumpkin	-	-	-	-	-	-	2,046	1,020	380	358	1,500	1,750	2,000	2,500	3,000
Sweetcorn	-	-	-	-	-	-	483	-	-	64	100	125	150	175	200
Babycorn	-	-	-	-	-	-	-	-	23	41	100	1,000	2,000	3,000	4,000
Tomatoes	-	-	-	-	-	-	-	-	50	31	50	75	100	150	200
Chillies	-	-	-	-	-	-	-	-	253	188	1,000	1,250	1,500	1,750	2,000
Vegetables	-	-	-	-	-	1,800	470	-	-	-	-	-	-	-	-
Others	-	150	3,954	3,832	5,162	6,750	230	2,030	100	147	4,750	7,450	5,050	6,375	7,700
Total	200	800	11,313	24,840	20,057	26,850	6,770	6,221	9,682	2,928	15,000	20,000	30,000	40,000	50,000

Table 4
Incremental Benefit
(Million Baht, 1985 prices)

	1976	1977	1978	1979	1980	1981	1982	1983
1. Wet Season crop								
1.1 Non-glutinous rice	0.21508	0.21508	0.21508	0.46601	0.90335	2.35274	7.49413	21.5475
2. Dry Season crops								
2.1 Non-glutinous rice	0.28678	0.86034	9.962737	29.40642	16.40811	12.61832	1.041011	0.585031
2.2 Peanuts	-	0.06179	0.5079	0.6179	4.2633	11.7411	2.1752	2.9575
2.3 Watermelon	-	-	-	-	-	-	1.10775	0.3885
2.4 Pumpkin	-	-	-	-	-	-	1.7384	0.8666
2.5 Sweetcorn	-	-	-	-	-	-	0.3619	-
2.6 Babycorn	-	-	-	-	-	-	-	-
2.7 Tomatoes	-	-	-	-	-	-	-	-
2.8 Chillies	-	-	-	-	-	-	-	-
2.9 Vegetables	-	-	-	-	-	2.0111	0.5251	-
2.10 Others	0.171634	4.5243	4.3847	5.9065	7.7235	0.26317	2.3228	0.1144
3. Fishery	-	-	0.0257	0.0514	0.0922	0.1273	0.1496	0.1753
Total	0.50186	1.308849	15.23575	34.92647	27.57650	36.57403	14.85622	28.84324

Table 4: (continued)

	1984	1985	1986	1987	1988	1989	1990 and thereafter
1. Wet Season Crop							
1.1 Non-glutinous rice	43.4798	59.26452	-	-	-	-	-
2. Dry Season crops							
2.1 Non-glutinous rice	0.520505	-	-	-	-	-	-
2.2 Peanuts	9.0814	1.6512	6.1795	7.4154	8.6513	10.50515	12.3590
2.3 Watermelon	0.87885	0.58485	1.05	1.3125	1.575	1.8375	2.100
2.4 Pumpkin	0.3228	0.3042	1.2744	1.4867	1.6993	2.1241	2.5489
2.5 Sweetcorn	0.2458	0.1544	0.3747	0.4496	0.5245	0.5994	0.6744
2.6 Babycorn	-	0.29631	0.4630	0.0579	0.0694	0.0810	0.0926
2.7 Tomatoes	0.0421	0.0751	0.1831	1.8306	3.6612	5.4917	7.3223
2.8 Chillies	0.0979	0.6073	0.9795	0.1469	0.1959	0.2939	0.3918
2.9 Vegetables	0.1177	0.2100	1.11726	1.3966	1.6759	1.9552	2.2345
2.10 Others	0.1682	5.4351	8.5245	5.7784	7.2945	8.8106	8.810571
3. Fishery	0.1795	0.1838	0.1881	0.1924	0.1967	0.2009	0.2009
Total	55.24582	62.68651	17.8026	23.53015	38.36654	51.89186	65.41298
	11.7751	3.9662	11.9890	16.4569	21.8704	27.1061	26.7014

Table 5
Project Costs
(Million Baht, 1985 Prices)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
I. On-farm Development (rai)											
Intensive model	1,000	-	-	1,169	985	2,650	-	-	-	-	-
Extensive model	-	-	-	-	-	-	8,555	54,698	57,718	33,882	-
LNO model	-	-	-	-	-	2,400	-	-	-	-	-
II. Project costs (Million Baht)											
1. Construction costs	9.21375	-	-	10.77087	9.0754	30.41643	17.965	114.8658	121.2078	71.1522	-
1.1 Intensive model	9.21375	-	-	10.77087	9.0754	24.41643	-	-	-	-	-
1.2 Extensive model	-	-	-	-	-	-	17.965	114.8658	121.2078	71.1522	-
1.3 LNO model	-	-	-	-	-	6.00000	-	-	-	-	-
2. O&M costs for the system	-	3.3	5.3	5.5	7.6	10.0	12.8	12.8	12.8	12.8	12.8
3. On-farm extension by the specific assignment team	-	-	-	-	-	1.0	1.0	1.1	1.1	1.2	1.2
4. Promotion of industrial agriculture	-	-	-	-	-	-	-	-	-	-	2.5
Total costs	9.21375	3.3	5.3	16.27087	16.67554	41.41643	31.7655	128.7658	135.1078	85.1522	16.5

Table 5a
Projected Project Costs
(Million Baht, 1985 prices)

	1987	1988	1989	1990	1991 & thereafter
I. On-farm Development					
Intensive model	-	-	-	-	-
Extensive model	-	-	-	-	-
LNO model	-	-	-	-	-
II. Project costs					
1. Construction cost	-	-	-	-	-
1.1 Intensive model	-	-	-	-	-
1.3 LNO model	-	-	-	-	-
2. O&M costs for the specific assignment team	12.8	12.8	12.8	12.8	12.8
Total Costs	25.0	21.5	20.0	19.0	16.8

Table 6
Sensitivity Tests

	Discount Rate	B/C Ratio	IRR
Base Case	12	1.10943	15.5
	15	1.01576	
Case I: Non-glutinous rice in the wet season after 1985 is included in the benefit stream	35	1.0904	43.9
	45	0.9679	
Case II: Costs increase by 5%	12	0.9464	11.75
	15	0.9183	
Case III: Benefits increase by 5%	12	1.1649	16.75
	15	1.06655	
Case IV: benefits decrease by 5%	12	1.0539	14.0
	15	0.9650	

Table 7

Incremental Benefit Generated by the Project Sub-Areas
1985

Unit	Rai in Unit	Families in Unit	Incremental Economic Benefit per Sub-Area (1985, Baht/year)
1.	5,775	393	2,219,910
2.	6,407	450	2,462,851
3.	7,429	401	2,855,708
4.	15,910	722	6,115,804
5.	3,558	n.a.	1,367,695
6.	8,805	74	3,384,642
7.	3,922	372	1,507,617
8.	7,404	n.a.	2,846,098
9.	8,649	812	3,324,676
10.	13,400	711	5,150,960
11.	3,038	316	1,167,807
12.	2,154	232	827,998
13.	7,742	321	2,976,025
14.	9,065	550	3,484,568
15.	3,955	383	2,673,502
16.	8,073	874	3,103,261
17.	3,382	33	1,300,041
18.	5,243	291	2,015,409
19.	7,485	n.a.	2,877,231
20.	4,724	196	1,815,906
21.	6,865	n.a.	2,638,906
22.	15,501	n.a.	5,958,584
23.	1,577	n.a.	606,199

Note: Data on land area and families in sub-area obtained from LND project office. Data on incremental economic benefit of the sub-areas from calculations shown on Table 4.

ATTACHMENT D

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BIBLIOGRAPHY

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ATTACHMENT E

**TERMS OF REFERENCE
FOR
FINAL EVALUATION**

SCOPE OF WORK
for
Lam Nam Oon Final Evaluation

I. Description of Activity to be Evaluated

A. Project Title:	Lam Nam Oon Integrated Rural Development Project
B. Project Number:	493-0272
C. Cooperating Country:	Thailand
D. Project Funding: (\$000)	\$3,500 Loan; \$100 Grant
E. Project Agreement Date (Grant):	September 28, 1977
F. Project Agreement Date (Loan):	January 20, 1978
G. Project Assistance Completion Date:	September 30, 1985
H. Project Inputs (\$000)	
Construction	\$171
Technical & General Support	1,661
Technical Services	1,668
Total	<u>\$3,500</u>
	=====

II. Evaluation Purpose

This is the final project evaluation. The evaluation team will determine to what extent the project goals were met and prepare a final evaluation report in accordance with AID regulations. The evaluation report will include analyses of the approaches used during project implementation in the specialty areas of irrigation engineering, marketing, anthropology, development administration, and economics. The evaluation report will contain recommendations intended to improve the performance of irrigation systems now operating or planned in Thailand. In addition, the evaluation should provide

valuable insights for strengthening private sector participation in the continuing marketing effort in Lam Nam Oon, an activity to be funded under the Agricultural Technology Transfer Project (493-0337).

III. Background

The Lam Nam Oon Integrated Rural Development Project began in 1967 and continued through September 30, 1985. Initially USAID/Thailand provided \$3.5 million to assist the construction of the dam and primary distribution system. In 1977 USAID contributed an additional \$4.5 million in loan funds to allow completion of planned construction and the establishment of an integrated rural development program in the project area. The total construction costs are estimated at over \$60 million.

Though referred to as "small scale" irrigation, the 185,000 rai (74,000 acres) designated to be served by the system along with the magnitude of the delivery system itself, suggests at least "medium scale" effort. It should be noted, however, that traditionally in Thailand a "system" did not include "on-farm" works. The Lam Nam Oon Project was expected to supply supplemental water when required for the production of (largely glutinous) rice in the wet season and sufficient water for mostly non-rice dry season crops.

The Royal Irrigation Department (RID) estimates that about 100,000 rai can be served in the dry season. The RID also states that 12,500 families can benefit from the completed system.

With the establishment of a second USAID loan in support of the L.N.O. Project area (1977) the project goals were to:

- (a) improve the standard of living for the residents of the project area, as reflected in increased income, better health, increased educational opportunity, etc., and,

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- (b) demonstrate in a typical irrigated area of NE Thailand an integrated and coordinated approach to rural development which significantly increases agricultural production, and improves the quality of life over a broad spectrum.

IV. Work Statement

A. The evaluation team will consist of five contracted positions in addition to the USAID evaluation officer, one designated DTEC evaluation officer and the designated evaluation officer from the Ministry of Finance. Royal Irrigation Department and USAID project management personnel will also participate in the evaluation process. The five contracted positions will be funded and directly contracted by USAID using Project Development and Support Funds. The contracted positions are:

Team Leader Development Management Specialist (U.S. citizen)
Irrigation Engineer (U.S. citizen)
Anthropologist (Thai citizen)
Economist (Thai citizen)
Marketing Specialist (U.S. citizen)

B. The tasks assigned to the contracted evaluation team will include:

1. Review the project documentation and compare the project goals and objectives stated therein with actual accomplishments of the project.
2. Compare the operations and maintenance program of the Royal Irrigation Department before and after the project.
 - What are the major maintenance problems?
 - What percentage of O and M budget does each problem require and how are they solved.

3. Identify benefits derived from USAID funded activities in Lam Nam Oon. The project was designed to achieve a specific end of project status (EOPS) as stated in Project Implementation Letter Number 14. The evaluation will measure the progress made during project implementation toward these objectives.
 - The evaluation report should examine effectiveness of special assignment teams considering costs vs. benefits derived and potential for replicability.
 - The evaluation team should review NESSI audit and examine adequacy of future year O&M funding for LNO in light of NESSI audit recommendations.
 - The team should consider the integrated approach of LNO. Does such an approach divide the time of project staff and render the staff less effective as does such an approach result in balanced and efficient implementation.
4. Identify factors which limit farmer access to water in the LNO irrigation system.
 - What are the factors limiting access to water in the wet and dry seasons?
5. Compare dry season with rainy season use of the LNO system in terms of crop patterns (area and type of crops planted), number of farmers and specific problems encountered in each season by farmers and RID officials. Compare with/without project dry and wet season cropping patterns and intensity.
 - What are the major non-water limiting factors of production? Consider management, availability of seed, marketing information, capital, labor, markets, ethnolinguistic problems, etc.

- What is the volume of increased (or decreased) rice yield resulting from the project.
 - Is there a change in percent of glutinous rice vs. white rice?
 - Are there changes in home consumption?
 - Are there changes in the sale of rice?
6. Evaluate the microcomputer based water management system in terms of training cost and relative utility when compared with other non-computer managed irrigation systems in Northeast Thailand.
7. Assess quality and relevance of project funded training and extension efforts.
- What is the number of farmers benefiting from the use of LNO irrigation system water?
 - What percentage of the total project zone population does this represent?
 - What is the actual number of rai irrigated by LNO in the last 5 wet and dry seasons. (Team should prepare in graph form).
 - The evaluation team economist should compare costs and benefits between the three approaches RID has experience with "Land Consolidation", "Lam Nam Oon Model" and the "Ditch and Dike".
 - The team should evaluate the effectiveness of the Ban Fang Rural Development training Center.

- Was the training for zonemen, Special Assistance Teams (S.A.T.) and farmers appropriate?
 - What aspects of the DOA technology transfer programs and the non-formal education programs were most effective.
 - Assess orientation programs for Kaset Tambons and CD workers.
 - Was Dr. W. Bell's training of RID personnel on microcomputer systems relevant to the requirements of LNO? How is the microcomputer now being used to assist LNO in management?
8. Develop recommendations for strengthening private sector linkages in the LNO area.
- What crops show the most promise in LNO? What is the relationship between increased irrigation and these crops?
 - What are the requirements of the food processing plant funded under Royal patronage?
 - How can local farmers approach providing consistent and quality produce for the processing plant?

V. Methods and Procedures

The Ministry of Finance and DTEC will be given the opportunity to designate representatives from their evaluation/planning offices to participate in and observe the evaluation process. USAID will directly negotiate contracts with specialists for the five positions described in section VI. These five contracts will be issued against one PIO/T to be financed by Project Development and Support Funds (PD&S).

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A. Work Schedule

The contracted team members will be contracted for a total of 26 working days (31 for team leader).

The following schedule is suggested:

- Week 1 - Review project documentation and interview project personnel in Bangkok.
- Week 2, 3 - In Lam Nam Oon to interview farmers, RID officials, visit irrigation sites and private sector representatives.
- Week 4 - Further interviews with project officials and private firms. First draft in English of individual evaluation reports completed by team members. To be reviewed by AID before end of fourth week.
- Week 5 - Team leader integrates any AID revisions and coordinates submission by team members of evaluation report components.
- Week 6 - Final report produced and delivered to USAID by final working day of sixth week. Translation of report into Thai and production of one bilingual report will take place upon USAID acceptance of report.

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VI. Team Composition

1. Team Leader - responsibilities will include. (a) organizing and assignment of weekly work schedules for other team members; (b) review and edit as required, all preliminary and final drafts of evaluation components in order to ensure that the final report follows USAID evaluation criteria and is internally consistent; (c) review of LNO project literature as well as project documentation for other irrigation projects in the Northeast funded by USAID, World Bank, UN and other bilateral donors. Prepare bibliography of materials used during preparation of the evaluation report (bibliography to be appended to the evaluation report); (d) analyze and compare management structure of project with management structure of other donor projects in the area; (e) evaluate quality and relevance of RID training and extension programs; (f) assess quality and relevance to farmers of RID audio visual programs; (g) prepare recommendations for improvement of management structure of irrigation projects in the Northeast (applicable to RID and donor organizations); (h) prepare specific recommendations for future training requirements for farmers and RID officials.

2. Irrigation Engineer - responsibilities will include: (a) review of past, present and planned operation and maintenance programs implemented or planned by RID in the project area; (b) analysis of efficiency of computer use for water distribution; (c) survey entire irrigation system including on farm distribution system to identify problem areas; (d) estimate costs required to operate pumping stations in LNO; (e) prepare recommendations for improvements in RID procedures and for future USAID irrigation activities in Thailand.

3. Anthropologist - responsibilities will include: (a) review literature on history and social conditions in project zone; (b) interview a representative number of farm families in the project zone to determine problems and advantages perceived by farmers (this activity will require at least two weeks in the project area); (c) interview RID officials to determine problems and successes perceived by RID officials in their work with area

farmers; (d) prepare recommendations with specific suggestions for improving future AID projects and RID operations; (e) preparation of annotated bibliography of sociological and anthropological studies performed in project area.

4. Economist - responsibilities and include: (a) review of economics of irrigated literature in the Northeast; (b) preparation of an annotated bibliography on this subject; (c) analysis of costs and benefits for LNO irrigation operations; (d) prepare specific recommendations for improving efficiency of RID operations including O&M; (e) prepare specific recommendations for expanding private sector involvement in the project area.

5. Marketing Specialist - responsibilities will include: (a) review of all private sector activities in the project zone now available to farmers; (b) identification of new potential private sector firms with possible interest/expertise appropriate to agriculture in LNO; (c) specific recommendations for USAID marketing activity funded by the Agriculture Technology Transfer Project; (d) preparation of specific recommendations for RID that would enhance private sector involvement in LNO.

VII. Reporting and Debriefing Requirements

A. Presentation

Team Leader will present draft evaluation findings with team members to USAID at the end of week four. A presentation to a joint USAID/RTG meeting of the final report will take place within three weeks after week 6.

B. Report Format

The Team Leader will be responsible for meeting with the Mission Evaluation Officer and other USAID officials during the first week of the evaluation to ensure complete understanding of the scope of work and to make sure the report meets USAID requirements. The basic structure of the report includes the following sections:

- Executive Summary should include brief description of the development problem that the project responds to U.S. and Thai assistance to date, purpose of evaluation, and the team's findings and recommendations. Please refer to attached format.
- Discussion of findings, conclusions and recommendations.
- Attachments as required.

C. Period of Service

The work will begin in the second quarter of FY 1986.

<u>Position</u>	<u>Working Days</u>
Team Leader	31
Irrigation Engineer	26
Anthropologist	26
Economist	26
Marketing Specialist	26

Per diem will be provided for the contracted team members NTE 14 days in LNO. Team members who are residents in Bangkok will not receive per diem in Bangkok. Salaries will be commensurate within past earning history. Transportation to, from and within the project zone will be provided.