THE KINGDOM OF THAILAND

FEASIBILITY REPORT

ON

THE MAE WANG - KEW LOM IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

(MAIN REPORT)

MARCH 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Kingdom of Thailand in 1978, the Japanese Government has decided to carry out a feasibility study on the Irrigated Agricultural Development Project in MAE WANG - KEW LOM area aimed at an increase of agricultural products including upland crops through improvement and construction of facilities for irrigation, drainage and agricultural management.

The Japan International Cooperation Agency (JICA), entrusted with the work by the Japanese Government, despatched to Thailand a Preliminary Survey Team in February 1979, and a 10-expert team for feasibility study headed by Mr. SHIGEKATSU WATANABE, Sanyu Consultants Inc. for 3 months from July 1979.

This present report has been compiled on the basis of the results of the survey and analyses made after the return of the team to Japan.

I hope the report will prove to be useful for the agricultural development of the said area and will contribute to the promotion of the friendly relations between our two countries.

I wish to express my deep appreciation to the Thai authorities concerned for their close cooperation extended to the study team.

March 1980

Keisuke Arita

KEISUKE ARITA
President
Japan International Cooperation Agency

Mr. Keisuke Arita
President
Japan International Cooperation Agency (JICA),
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We have a great pleasure to submit herewith the feasibility study report on the Mae Wang - Kew Lom Irrigated Agriculture Development Project in the Kingdom of Thailand.

The report, consisting of two volumes of Main Report and its Annex, has provided the results of the field works conducted between July 15 and October 13, 1979, and many discussion meeting held among the study team and Thai authorities concerned in the same period.

The Project aims at irrigating the objective fields of about 22,700 ha by the water to be conveyed from the Kew Lom Dam through the existing main canals as well as consolidating the on-farm facilities and assuring of the farmers concerned to be benefited from this Irrigated Agriculture Development Project.

We are convinced that our strategy to the Project will sharply increase the farm production in this Area and the Project will give a good example to stimulate the Thai farmers for the on-farm development in future, and furthermore, we earnestly hope that this undertaking will greatly contribute to the socio-economic development of the country.

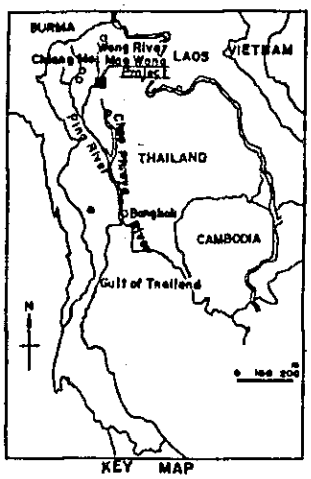
We wish to express our sincere thanks to the Royal Irrigation Department, Department of Agricutlure, Central Office of Land Consolidation, Department of Land, Department of Agricultural Extension, and many other organizations and agencies of the Government of Thailand, and Ministry of Foreign Affairs, the Japanese Embassy in Bangkok, Ministry of Agriculture, Forestry and Fisheries of the Government of Japan, and Japan International Cooperation Agency (JICA), the Supervisory Group, and many Japanese experts serving in Thailand for their closest cooperation and worthwhile advices given to us from time to time.

March 1980

Sincerely Yours,

Shigekatsu Watanabe,
Leader of Feasibility Study Team for
The Mae Wang - Kew Lom Irrigated
Agriculture Development Project

LOCATION MAP



N

KEW LOM DAM

WANG RIVER

SOP ANG DIVERSION DAM

KEW LOM MAIN CANAL

TUI RIVER

MAE WANG RIGHT MAIN CANAL

MAE WANG LEFT MAIN CANAL

LAMPANG CITY

WANG RIVER

MAE PUNG MAIN CANAL

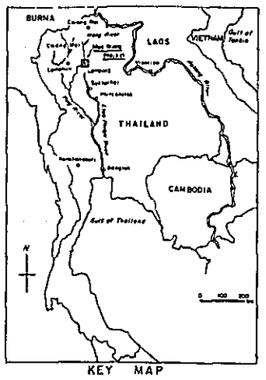
PUNG RIVER

MAE CHANG DAM SITE

CHANG RIVER

LEGEND

- RIVER
- IRRIGATION CANAL
- ZONE BOUNDARY
- ① ZONE NUMBER



PROJECT MAP

MAE WANG – KEW LOM

IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

KEW LOM DAM

SOPANG DIVERSION DAM

KEW LOM MAIN CANAL

No.1 DRAIN

No.6 DRAIN

No 2 DRAIN

No 7 DRAIN

MAE WANG LEFT MAIN CANAL

No 8 DRAIN

MAE WANG RIGHT MAIN CANAL

No.9 DRAIN

No.3-1 DRAIN

No 3 DRAIN

MAE TUI RIVER

MAE WANG RIVER

No.4 DRAIN

MAE PUNG MAIN CANAL

LINK CANAL

MAE PUNG RIGHT CANAL

MAE PUNG LEFT CANAL

No.5-1 DRAIN

MAE CHANG RIGHT MAIN CANAL

MAE CHANG DAM

No.5 DRAIN

MAE CHANG RIVER

LEGEND

- PROJECT BOUNDARY
- BOUNDARY OF NEW CITY PLAN
- ZONE BOUNDARY
- ① NAME OF ZONE
- EXISTING MAIN IRRIGATION CANAL
- MAIN IRRIGATION CANAL TO BE IMPROVED
- EXISTING LATERAL IRRIGATION CANAL
- LATERAL IRRIGATION CANAL TO BE IMPROVED
- MAIN DRAINAGE CANAL TO BE IMPROVED
- RIVER
- INTENSIVE ON-FARM DEVELOPMENT AREA
- EXTENSIVE ON-FARM DEVELOPMENT AREA
- FOREST LAND

SCALE

1 0 1 2 3 4 5 km

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CURRENCY EQUIVALENTS, WEIGHTS AND MEASURES, ABBREVIATIONS AND GLOSSARIES

CURRENCY EQUIVALENTS, WEIGHTS AND MEASURES, ABBREVIATIONS AND GLOSSARIES

Currency Equivalents

Japanese Yen	¥1.00 = US$0.005	(= ฿0 10)
US Dollar	US$1.00 = ฿20.00	(= ¥200.00)
Thai Baht	฿1.00 = ¥10.00	(= US$0.05)

Weights and Measures

1.00 rai	= 0.16 hectare
1.00 hectare	= 6.25 rai

Abbreviations

ALRO	Agricultural Land Reform Office
BAAC	Bank for Agriculture and Agricultural Cooperatives
COLC	Central Office of Land Consolidation
DAE	Department of Agricultural Extension
EIRR	Economic Internal Rates of Return
EL	Elevation above mean sea level
HYV	High Yielding Varieties
JICA	Japan International Cooperation Agency
MK-IADP	Mae Wang - Kew Lom Irrigated Agriculture Development Project
MOAC	Ministry of Agriculture and Cooperatives
O & M	Operation and Maintenance
RID	Royal Irrigation Department

Glossaries

Changwat	province
Amphoe	district
Tambon	sub-district
Muban	villages
Muang	capital of province

SUMMARY, CONCLUSION AND RECOMMENDATIONS

SUMMARY, CONCLUSION AND RECOMMENDATIONS

A. General Description of the Project Area

A.1. The Project Area is located in Changwat Lampang, 650 km north of Bangkok the Capital of Thailand, covering about 22,700 ha, in the centre of which there flows the Wang River, the water resources for the Project. The Project Area, which is the paddy field area with comparatively steep slopes, extends on the both banks of the Wang River, stretching about 45 km from north to south and about 12 km from east to west at widest portions.

A. 2. The transportation networks in the Project Area are well arranged with the major facilities of the railway, highway and airway all of which link Bangkok with Chiang Mai, the old city in the North, passing through the Project Area.

A. 3. The Project Area has climate of tropical savanna having two seasons in a year, the dry season between November and April, and the wet season between May and October. The annual mean temperature at Lampang is 26°C and the annual mean rainfall is about 1,100 mm. About 88 percent of the total annual rainfall concentratively takes place in the wet season, and that in December through February occupies only two or three percent of the total rainfall

A. 4. The population density in habitable area of Changwat Lampang is 169/km^2, which is slightly larger than the national average of 149/km^2. The population growth rate in the Changwat is 1.1 percent per annum which is lower than that of the national average of 2.5 percent recorded during 1975 to 1978.

A. 5. Soils in the northern part of the Project Area belong to loam or silty loam, which are cultivated as paddy fields or upland fields. Soils in the central and the southern parts are sandy loam or sandy clay loam, which form a good paddy field area with comparatively high fertility and drainage conditions.

A. 6. Out of 22,700 ha of the Project Area, presently cultivated paddy fields are 12,300 ha (54.2%) upland fields 2,250 ha (9.9%), orchards 250 ha (1.1%), and forest lands and village area/roads are 3,000 ha (13.2%) and 4,900 ha (21.6%) respectively. A settlement project has been executed in the Project Area and settler farmers are undertaking land reclamation works.

The major crops grown in the wet season are paddy (88%), peanut (3%), vegetables (2%), etc., while those in the dry season are peanut (29%), tobacco (16%), garlic (12%), paddy (11%), etc. with about 30 percent of the cropping ratio for the

whole area. The farming techniques applied in the Area are at considerably high level in practicing intensive farming so as to produce the yield of wet season paddy by 2.8 ton/ha.

A.7. The land holdings per farmer average about 1.3 ha, which are rather low as compared with the national average. The owner farmers, however, occupy about 93 percent of the total farmers in Lampang that covers more than 70 percent of the Project Area, and the owner farmers in Amphoe Mae Tha occupy about 99 percent and in Amphoe Ko Kha about 98 percent respectively. Such high rate of owner farmers will facilitate the land substitution procedures in the on-farm development works.

A.8. At present, about 5,650 ha in the Mae Wang left bank of the Project Area has been irrigated by water diverted at Sop Ang Diversion Dam and through the Mae Wang left main irrigation canal, both of which were constructed about 40 years ago. The Mae Pung area with about 3,190 ha in the southern part of the Project Area has been suffering from chronic water shortage due to its irrigation water sources depending on the surplus water from the Mae Wang left bank irrigation canal and unstable river discharge of the Pung River. About 2,900 ha of paddy fields and upland fields of the newly reclaimed Kew Lom Stage I (Kew Lom Extension) area has been irrigated by stable water supply from the recently constructed Kew Lom Dam and its related main and laterals. The Mae Wang right bank area with about 3,020 ha is currently supplied with water diverted from the Kew Lom main canal at the rate of about 4.0 m^3/sec due to difficulty in diverting water at the Sop Ang Diversion Damby heavy sediment around the intake site.

Completion of the Kew Lom Dam in 1972 has enabled to secure the sufficient water for year-round irrigation of the Project Area; however, water utilization has been still ineffective due to the fact that most of the existing main canals, except for the Kew Lom main canal, are the earth canals with check structures sparsely provided.

A.9. A very few land consolidation works have been implemented in the Project Area, and consolidation of farm ditches/drains and roads networks would play a vitally important role for expanding the dry season cropping. About 100 ha Pilot Farm for land consolidation, which was constructed in 1978 by Thai authorities concerned, serves to deepen the farmers' understanding on the effect of on-farm development projects and make them acquire the desire for early implementation of the land consolidation project in the Area.

A.10 The Project Area, which became involved in the objective areas of the national agricultural extension program in 1977, has been increasingly provided with extension and training facilities and extension agents in number. The Project Area has only one horticulture experiment station in Lampang as the agricultural research institute, but Chiang Mai the largest municipality in the North, located about 90 km northwest of Lampang, is well provided with various research institutes for agriculture which will be in a position to render services for experimental works of the Project-related agricultural study. The agricultural cooperatives have been organized in three Amphoe respectively; however, the entry rate of the membership is as low as about 17 percent of the farmers in the Project Area.

The main services made by these cooperatives are to follow the procedures of the agricultural crediting for the member farmers.

A.11. There are two Project-related development schemes, the Settlement (NIKOM) Project in the Kew Lom area and the Lampang City Planning Project; the former aims at relieving the farm families which were transfered from the submerged area in the Kew Lom Dam construction. The settlers have been given about 2.0 ha allotted land per family and been making land reclamation by their own effort, and the Government has constructed roads and houses for their conveniences.

The latter aims at developing the urban area of Lampang and its surroundings in keeping the harmony in the living environment, including the Lampang city area with 2,900 ha of beneficial area, among which about 1,300 ha of the farm lands are involved. This project will be implemented at slow but steady pace under the longterm programme.

B. Outline of the Project

B.1. The purposes of this Project is to encourage the agriculture in the Project Area, to provide opportunities of employment for the local inhabitants, to establish the double cropping system and to consolidate farm lands and construct and/or improve the agricultural facilities for more effective utilization of the water resources. The following schemes are planned to accomplish the above purposes.

B.2. The main and lateral irrigation canals will be improved and consolidated so as to supply the adequate irrigation water to the farm lands as well as the necessary facilities will be installed in order to carry out proper water management and water distribution.

B.3. The main drainage canals will be improved so as to provide the farm lands with conditions available for introducing the high yielding varieties and various upland crops to the Area.

B. 4. Together with consolidation of the main facilities, farm ditches/drains and farm roads, plot reparcelling and land levelling, if necessity arises, will be carried out. The land consolidation plan will be made to cover the entire Project Area for comprehensive execution of these works.

B. 5. The operation and maintenance (O & M) roads will be provided along every main and lateral canals for upgrading the O & M services to the irrigation and drainage facilities. Furthermore, the O & M organization will be reinforced in both terms of staffing and facilities, and the necessary education and training on the water management at on-farm level will be given to the farmers concerned.

B. 6. Under the cooperation with regional agricultural research institutes and extension agencies concerned, the experimental farms will be provided in the fields during the Project execution or even in the post-project so as to encourage agriculture in the Project Area, diffuse the advanced farming techniques and increase the agricultural production through expansion of dry season cropping areas and introduction of new farming technology.

B. 7. During the project implementation, social and environmental changes will be surveyed and the guidelines for agricultural extension activities will be established along with the results to be obtained from the above survey. Furthermore, the socio-economic survey will be conducted to properly allocate the construction cost and water charges to the beneficiary farmers.

B. 8. The proposed land use will be specified into 13,400 ha for paddy fields, 1,750 ha for upland fields and 250 ha for orchards totaling 15,400 ha, in taking into account the modification of land categories which may take place in the Kew Lom Stage I (Extension area) development. The dry season cropping will be practised in introducing upland crops positively and increasing cropping ratio by about 80 percent so as to develop more profitable and intensive farming in the Project Area, although the wet season cropping will remain at almost the same level as the present one.

B. 9. As the results of water balance computation for the Kew Lom reservoir, annual runoff discharge was about 498 MCM at the dam site in 1967 which is drought year of ten-year probability, while the necessary irrigation water in the Project Area including Kew Lom Stage II area was approximately 241 MCM (48%) in the same year. The

runoff discharge seems abundant compared with irrigation water requirements. However, when the original dam operation rules are adopted in the water balance computation, water shortage occurs during the dry season due to a rather few rainfall in the season. The study was made to modify the operation rule according to which the release discharge from the dam corresponds to nearly same of the water requirements in the Project Area. In case of including Mae Pung area, the water shortage volumes are about 34 MCM for year-round irrigation, while excluding Mae Pung area these volumes are only 14 MCM. After completion of the Kew Kor Mah Dam which will be constructed upstream of the Kew Lom Dam, the above mentioned problems will be dissolved.

B. 10. The proposed major items in the construction works are improvement of the main irrigation canal for about 100 km, construction and/or improvement of the laterals and sub-laterals for about 80 km, improvement of the main drainage canals for 61 km, and on-farm development in the paddy field areas for 12,445 ha. The on-farm development will be implemented by either method of intensive or extensive according to the results of surveying, soil survey and detailed designs for the selected five-sample areas, and the areas to be developed are estimated at 6,208 ha (50%) by intensive method and 6,237 ha (50%) by extensive method, respectively. No investment will be made to the land improvement works for 973 ha of farm lands located in zone No.2 and 3 covered by the Lampang City Planning Project.

B. 11. The Project works will be executed by the Mae Wang - Kew Lom Irrigated Agriculture Development Project Office, RID under the support and cooperation of RID and the MOAC's Departments concerned and Land Department of the Ministry of Interior. The coordination committies will be organized at each level to meet the Project requirements for smooth execution and management of the related works.

B. 12. The proper O & M of the facilities to be consolidated and the effective water utilization will require to expand and reinforce the Mae Wang O & M office both quantitatively and qualitatively. On top of the above, the education and training will be given to the farmers concerned for upgrading the O & M technique of the on-farm facilities as well as the Irrigation Water Users' Association will be strengthened for more effective water utilization.

B. 13. Since the Project implementation takes about two years for preparatory works such as aerial photogeommetry, surveying and design for the Area, the total Project execution period is scheduled to last seven years. The construction works are planned to take five years in due consideration of quick-yielding of the Project, actual results of construction works undertaken on the RID's force account basis and construction capability of the contractors.

B 14. The total cost to be required for this Project is estimated at 607 million Baht, including the foreign currency component equivalent to about 267 million Baht to cover the procurement of the machinery/equipment, imported construction materials, consultants fee, and so forth, occupying about 44.1 percent of the total amount.

C. Project Evaluation

The Project is anticipated to generate an incremental benefit of about 260.6 million Baht from the development in the Post Project stage. The economic internal rate of return - the economic analysis index to the Project investment - shows 27.1 percent and the sensitivity analysis results in more than 22.6 percent in the EIRR value.

D. Conclusion

The Project will assure the agricultural production increase, formation of production blocks of the specific crops and increase in cropping intensity to be materialized in the Area by staged on-farm development and provision of the main facilities; hence the increase in agricultural employment opportunities and stable farm income are expected. Therefore, judging from economic internal rate of return and its sensitivity analysis, the Project is considered technically sound and economically and financially feasible.

E. Recommendations

E. 1. The Mae Pung area in the Project Area (zone No.5 and 6 with irrigable areas of 3,186 ha) is classified into the beneficial areas of the Mae Chang Dam Project now under contemplation by RID. The Mae Chang Dam Project aims at irrigating about 16,000 ha areas by constructing the Mae Chang Dam with about 135 MCM capacity at the upperstream of the Chang River flowing through the southern end of the Project Area.

The Mae Pung area, which is commanded by the Chang River system, and supplimental water supply from the Mae Wang Left Main canal, has been suffering from chronic water shortage even in the wet season due to lack of adequate water resources. Therefore, it is a matter of urgency to construct the Mae Chang Dam by possibly early commencement of study and design of the related works.

E. 2. The results of soil survey conducted for the sample areas has suggested that there exist some farm lands for which the top soil treatment should be implemented in land levelling, and further detailed soil survey is required prior to implementation for the area where the intensive development method would be applied.

E. 3. The estimated difference between the outer water level (river water level) and the inner water level (drainage canal water level) at the confluences of the Wang River and the main drainage canals suggests that the detailed study would be necessary for providing the drainage sluices at the proper site of the canals. The water level observation should be carried out at the respective proposed confluences to determine the sluice section according to probable outer water level and discharge from the Project Area.

E. 4. The MK-IADP aims chiefly at agricultural production increase with double cropping available by full-scale on-farm development for the entire Project Area and effective utilization of abundant water resources. The existing topo-maps were prepared 10 years ago, having discrepancies to the present situation by modification of land categories. On the other hand, the cadastral maps are essentially required for implementing the land consolidation works. Under the circumstance, it is urgently required to carry out the aerial photogrammetry to cover the whole Project Area to prepare the latest editions of topo-and cadastral-maps for the use of on-farm development of the Area. In general, the 1/4,000 scale is acceptable for the said maps, but it is desirable to possibly prepare the 1/2,000 scale maps in due consideration of the fact that the land holdings per farmer is comparatively small with small plot size.

E. 5. For smooth and successful execution of the Project, it is essential to assign the experienced personnel in charge of project execution at the earliest, so that they can work out the detailed plan with rich experience in the past undertakings. Particularly, since the design of on-farm development may take unexpectedly long time to negotiate with the beneficiary farmers, the well-experienced personnel should be assigned to this coordination work under the closest cooperation with the agency concerned.

CHAPTER I. INTRODUCTION

CHAPTER I INTRODUCTION

In compliance with the request by the Government of Thailand, the Government of Japan dispatched the field survey team through the Japan International Cooperation Agency (JICA), the executing body of Japanese Government for the overseas technical cooperation, for conducting the survey and study of the Mae Wang - Kew Lom Irrigated Agriculture Development Project in the Kingdom of Thailand according to the result of the preliminary survey made in February, 1979, and the field survey team has studied the feasibility of the said Project through preparation of the irrigated agriculture development plan in the total area of about 22,700 ha.

The Project Area is located in Changwat Lampang about 650 km north of Bangkok, the capital of Thailand, having been under somewhat intensive farming of paddy cropping in the wet season and paddy and several upland crops in the dry season.

The survey team had been in the field for about three months from July 15 to October 13, 1979 to perform surveyings, field investigation, data collection, many discussions and exchanges of opinion with the Thai Officials concerned which were necessary for establishing the Project formulation, and has prepared the feasibility report in Japan based on the findings obtained from the field works.

This feasibility report has been compiled according to the results of surveys and studies conducted in the fields, and discussion and consultative meeting held among the Thai authorities concerned, the supervisory group and the team. The names and titles of the members of the supervisory group, the survey team, and the Thai counterparts personnel who were engaged in this Project study are listed as follows:

Supervisory Committee, Study Team Members and Thai Government Personnel Contacted

A. Supervisory Committee Members

Name	Position
1. Mr. Shigetoshi MORIMOTO (Chairman)	Technical Advisor Design Division, Agricultural Structure Improvement Bureau (ASIB) Ministry of Agriculture, Forestry and Fisheries (MAFF)
2. Mr. Kazushige TORIHATA (Member)	Deputy Director Design Division, ASIB, MAFF

	Name	Position
3.	Mr. Saburo NEGAYAMA (Member)	Deputy Director Resources Division, ASIB, MAFF
4.	Mr. Mitsuo OSADA (Member)	Director, Regional Planning Division, Chugoku-Shikoku Regional Agricultural Administration Office, MAFF
5.	Mr. Katsuyuki TAKEUCHI (Member)	Deputy Manager, 1st Technical Appraisal Division, Overseas Economic Cooperation Fund (OECF)
6.	Mr. Takumi OHASHI (Coordination)	Senior Officer, Technical Affairs Division, Japan International Cooperation Agency (JICA)

B. Study Team Members

	Name	Period
1.	Mr. Shigekatsu WATANABE (Team Leader)	Jul. 12, 1979 to Mar. 4, 1980
2.	Mr. Satoshi KADOWAKI (Deputy Team Leader cum Land Consolidation)	Jul. 23, 1979 to Mar. 15, 1980
3.	Mr. Yoichiro GOMYO (Irrigation & Drainage)	Jul. 19, 1979 to Dec. 1, 1979
4.	Mr. Takanori TAKATSUKA (Hydrology)	Jul. 12, 1979 to Jan. 10, 1980
5.	Mr. Yoichi YAMAGUCHI (Survey)	Jul. 15, 1979 to Nov. 15, 1979
6.	Mr. Shinichi YAMADA (Structure)	Jul. 15, 1979 to Nov. 15, 1979
7.	Mr. Norio KOIWA (Soil)	Aug. 5, 1979 to Dec. 1, 1979
8.	Dr. Jisuke TAKAHASHI (Agronomy)	Aug. 5, 1979 to Dec. 1, 1979
9.	Mr. Tetsuo DOKIYA (Rural Development)	Aug. 5, 1979 to Jan. 26, 1980
10.	Mr. Mitsutomo ANAI (Agro-Economy)	Aug. 15, 1979 to Mar. 15, 1980

C. Thai Government Personnel Contacted

	Name	Position
1.	Mr. Charin Atthayodhin	Secretary General, ARLO
2.	Mr. Amphan Punnakant	Deputy Director General, RID
3.	Mr. Paitoon Palayasoot	Director, COLC
4.	Mr. Damrong Jaraswathana	Director, Hydrology Division, RID
5.	Mr. Phayool Chantasiro	Director, Topographic Survey Division, RID
6.	Mr. Boonthai Olagandnta	Director, Design Division, RID
7.	Mr. Youth Kingkate	Director, Irrigation Regional Office II, RID
8.	Mr. Danai Triyodben	Chief of Land Classification Section, Soil & Geology Division, RID
9.	Miss Supha Sing-Intra	Chief of Economic Section, Project Planning Division RID
10.	Mr. Osot Chawvet	Agronomist, O & M Division, RID
11.	Mr. Chalermthep Ratanaprayok	Deputy Director General Office, RID (Coordination)
12.	Mr. Ananda Karunyakarn	Chief of Land Consolidation Section, O & M Division, RID
13.	Mr. Boonlu Poolsawasdi	Engineer, Land Consolidation Section O & M Division, RID
14.	Mr. Somthob Kaewyen	Engineer, Irrigation Regional Office II, RID
15.	Mr. Thavat Tantitherarut	Manager, Mae Wang O & M Office, RID
16.	Mr. Preecha Cholsangkar	Engineer, Topographic Survey Division, RID
17.	Mr. Thana Jarupume	Engineer, Design Division, RID
18.	Mr. Prasert Milintarakook	Engineer, Hydrology Division, RID
19.	Mr. Sangad Onnume	Economist, Project Planning Division, RID
20.	Mr. Pittaya Hiranburana	Economist, Project Planning Division, RID
21.	Mr. Sinsiri Nacabodee	Chief of Land Consolidation Section, Ministry of Interior

CHAPTER II PROJECT BACKGROUND

CHAPTER II PROJECT BACKGROUND

2.1. National Economy and Agriculture

The territory of the Kingdom of Thailand covers some 514,000 km². The population is about 45.1 millions (as of 1978) and its annual growth rate has tended to decline from 2.6 percent in 1976 to 2.4 percent in 1978. The Thai economy in terms of Gross National Product (GNP) had grown from its annual growth rate of 5.4 percent in 1974 to 8.7 percent in 1978. The GNP per capita in 1978 was estimated at about 9,850 Baht (US$490). A study on the region-wise GNP per capita revealed that the value of the North involving the Project Area was as low as about 6,450 Baht equivalent to 65.5 percent of the national average and only 44.3 percent of 14,550 Baht generated in the Bangkok Metropolitan Area. Thus, the country has still many problems such as regional disparity in income distribution, unemployment, etc. in spite of the increase in its GNP.

The Government of Thailand has established the Fourth Five-year Social and Economic Development Plan (1977 - 1981) as a ground for the nation's development, aiming at promoting economic recovery, correcting disparity in income distribution, controlling population growth, promoting grade-up of human resources, developing employment opportunities, stably supplying food, improving living environment, securing national unity and security, correcting international trade imbalance, etc.

The Net Gross Domestic Product (NGDP) in agricultural sector in 1978 amounted to about 70 billion Baht, which accounted for 27 percent of the total NGDP, with about 78 percent of the employment rate of the national figure.

The average annual paddy production has marked 14.2 million tons in the recent five years (1973 - 77), out of which average 1.5 million tons have been exported, although having some fluctuation in its amount year by year. The GDP in the recent five year (1974 - 78) has indicated about 35 percent increase, whereas that of the agricultural sector has indicated only 22 percent increase. This shows clearly the fact that there exists the regional disparity in income distribution between rural areas and urban areas. In the country, about 80 percent of the nation live in the rural areas depending upon agriculture. Therefore, in order to accomplish the government's target of "raising the local farmers' income and living standard", it is indispensable to increase the agricultural production by enhancing productivity of labour and land due to the fact that there will be little potentiality in expanding the arable lands and cultivation of the necessary water resources.

Thus, the Government has taken up preferentially the enhancement of the land productivity, aiming at yield increase by implementing land reform, land consolidation and employing improved farming techniques in the Area as well as by implementing consolidation of the main irrigation/drainage facilities and raising the cropping intensity in the irrigable lands and effectiveness in water utilization.

For the development along with the above guideline for the development, it is essentially required to maintain the role of agriculture in the GDP, to grade up the living standard of the local people, to correct the disparity by regions and industries, and to provide fair employment opportunity throughout the nation.

2. 2. The Role of Irrigation in the Agricultural Development Projects

In Thailand, irrigation projects have a long history starting in Chiang Mai area in the North about 700 years ago. Since it origin, the cropping acreage with paddy has been expanded with water supplied from rivers and streams. On the other hand, the canal networks for navigation ever provided in the central plain together with installation of the check facilities in the canals.

Since 1904 when the Royal Irrigation Department was established, many irrigation facilities have been constructed to supply supplemental irrigation water for the wet season paddy cropping carried out in a vast area. Recently, multipurpose water storage dams for irrigation, power generation and flood control have been constructed together with canal networks and diversion facilities, and the irrigation water supply has been carried out through these facilities not only for the wet season cropping but for the dry season cropping in particular areas.

At present, about 75 percent of the total farm lands in the country are rainfed fields, and the fields where the effective wet season irrigation is expected was estimated at about 1.63 million hectares of the total irrigable area of 3.17 million hectares (51.4%).

The expected dry season irrigable area was estimated at about 770,000 hectares, out of which about 320,000 hectares (2% of the total arable lands) have been adequately irrigated and enabled to be cropped in two crops per year. About 1.32 million hectares had been provided with the on-farm facilities as of the end of 1978.

According to the Ditches and Dykes Act enacted in 1962, an on-farm development programme was established to secure effective water distribution to the fields of about 2.07 million hectares, and about 1.26 million hectares (61% of the above)

have been provided with on-farm facilities as of 1979. However, these existing on-farm facilities can be said to be still in adequate in terms of their function for effective water utilization.

On such background, the Government enforced the Land Consolidation Act in 1974 and the Land Reform Act in 1975 so as to raise land productivity and land use rate, and has been promoting the irrigated agriculture development programme as one of the mainstays of the Fourth Five-year Social and Economic Development Plan.

The on-farm development planned under the Land Consolidation Act has counted six projects covering the total beneficial area of about 200,000 ha, out of which about 57,000 ha have been already completed in their implementation as of the end of 1979.

The irrigation and drainage schemes, thus, play a vitally important role in the agricultural development projects. It is deemed as a matter of urgence that provision and improvement of the on-farm facilities are made through implementing on-farm development projects for agricultural production increase in the efficient utilization of developed water resources and irrigation facilities.

2. 3. Existing Irrigation Facilities and On-farm Development in the Project Area

The existing main irrigation facilities in the Project Area are under different conditions from each other; out of the 15,400 ha proposed beneficial areas, 8,066 ha in the Mae Wang area (52.4%) are commanded by the Sop Ang Diversion Dam and the related main and lateral canals which were constructed about 40 years ago, 2,963 ha (19.2%) in the Mae Pung area of the southern part of the Project Area are irrigated by the surplus water from the Mae Wang area and the water of the Pung River, having the rainfed paddy fields sporadically existing in the area due to water shortage, and 3,292 ha in the Kew Lom area at high elevation are irrigated by the main and lateral canals for which the water is diverted from the Kew Lom Dam constructed in 1972. There are no on-farm facilities, however, provided in the Project Area, excepting for a pilot farm (about 100 ha) constructed in 1978.

As for land tenure in the Project Area, land holdings per family average about 1.3 ha (about 8.0 rai) which is equivalent to only 32.5 percent of the national average of about 4.0 ha. This appears to be the fact to which a special attention should be paid in the study of the agricultural development in the Area.

A comparatively intensive farming has been practiced in the Area, although the several agriculture problems exist. However, farm income per farm labour was estimated at 4,100 Baht per annum in 1978. Under the circumstances with limited land resources, land and labour productivity should be increased for higher income by raising cropping ratio, growing more profitable crops, improvement of farming techniques, etc.

The first priority should be given to securing stable supply of irrigation water by consolidated irrigation facilities in order to accomplish these purposes. The drainage and road facilities will be constructed to cope with the situation of the Area which provides few problems in drainage conditions. The on-farm development scheme should be urgently established to develop the Area comprehensively.

The Project, therefore, should be implemented in the most effective way available in the staged manner of on-farm development in taking into account the above mentioned conditions, the related socio-economic factors, the wishes of farmers concerned, and so forth. It is essentially required to give an administrative guidance and education to the beneficiary farmers on the long-term prospect in order to realize the on-farm level water management by beneficiary farmers themselves, grade-up the relating techniques, extend advanced farming techniques, supply the farm input materials stably and improve the agricultural credit activities, etc. as well as to carry out investment to the land improvement works.

CHAPTER III THE PROJECT AREA

CHAPTER III THE PROJECT AREA

3. 1. The Local Conditions

3. 1. 1. Location

The Mae Wang - Kew Lom Project Area is located in the Changwat Lampang about 650 km north of Bangkok - the metropolis of Thailand, having an area of 22,700 ha in gross. The Wang river, which is a resource of irrigation water supply for the area, flows through the centre of the Project Area. The Project Area is a paddy field area extending on the both banks of the Wang river with about 45 km length from north to south and about 12 km width from east to west at the widest portion.

3. 1. 2. Transportation

The major transportation facilities in the Project Area are roads, railways and airways, trunk lines of which are provided running through the Project Area between Bangkok and Chiang Mai, the northern old city of the country. The Asian Friendship Highway and the National Highway No. 11 between Chiang Mai and Lampang pass through the Project Area. These trunk roads are arranged in harmony with the local road networks and establish a functional regional transportation system. Other minor roads in the Project Area have about 360 km in total length and the O & M roads provided along canals and farm roads reach about 140 km in total length and all of them are used as farm roads in the area.

The National Railway of Thailand runs between Bangkok and Chiang Mai passing through Lampang and the trains take about one hour from Lampang to Chiang Mai

The Thai Airway Co. (TAC), is operating regular flights between Bangkok and northern cities and the passengers for these flights have been increasing in number recently.

3. 1. 3. Population

(1) Density

The population density of Thailand was estimated at 88 persons per square kilometer in 1978. Region-wise density was 56 persons/km^2 in the North (53 persons/km^2 in Changwat Lampang), 91 persons/km^2 in the Northeast, 135 persons/km^2 in the Central, 85 persons/km^2 in the South respectively. The reason why the North is most thinly populated is that the North has a wide forest land in its region. In assuming that the areas excluding the forest land are habitable, the population density in

these areas in the Central Plain including Bangkok was thickest by 218 persons/km^2, and those of the other regions were estimated at around 130 persons/km^2 on an average. The population density for habitable area of Changwat Lampang including the Project Area was estimated at 169 persons/km^2 which is larger than the national average of 149 persons/km^2.

Population Density

Region	Total[1] Acreage (A) km^2	Total[2] Population (B) 1,000 persons	(1) Density (B)/(A) persons	Acreage[3] of Forest Lands (C) km^2	(D) = (A) - (C) km^2	(2) Density (B)/(D) persons
North	170.006	9,544	56.1	95,147	74,859	127.5
(Changwat Lampang[4])	(12,518)	(666)	(53.1)	(8,572)	(3,946)	(168.8)
Northeast	170,226	15,943	93.7	52,175	118,051	135.1
Central Plain	103,579	14,055	135.7	39,006	64,573	217.7
South	70,189	5,558	79.2	24,333	45,856	121.2
National	514,000	45,100	87.7	210,661	303,339	148.7

Sources: 1/ Office of the Prime Minister, "Thailand Year Book 1975 - 76"
2/ "Population of Thailand by Provinces 1970 - 1978" NESDB
3/ Land Utilization of Thailand 1975, Agricultural Statistic Bulletin No.57

Note: 4/ The figures stated on Changwat Lampang in parenthesis is included in those of the North.

(2) Population Increase

The national population increase and that of the North and Changwat Lampang are shown in the following table.

The annual increase rate for Changwat Lampang was estimated at 1.04 percent for seven years, which is lower than that of national average by 2.63 percent and the average of the North by 2.31 percent.

Population Increase

Unit: 1,000 persons

Year	National		North		Changwat Lampang	
	Population	Increase Rate %	Population	Increase Rate %	Population	Increase Rate %
1972	38,592		8,323		626	
		2.85		2.50		0.48
1973	39,693		8,531		629	
		2.74		2.43		0.79
1974	40,782		8,738		634	
		2.67		2.36		1.74
1975	41,869		8,944		645	
		2.61		2.31		0.93
1976	42,961		9,151		651	
		2.51		2.22		1.23
1977	44,039		9,354		659	
		2.41		2.03		1.06
1978	45,100		9,544		666	

Source: "Population of Thailand by Provinces 1970 - 78" NESDB

(3) Agricultural Population

The number of households in the Project related 78 bans totaled to 18,247 and the population was 89,538 persons in 1978. The farm households and their population were estimated at about 12,400 households and about 28,900 persons, respectively, according to the Changwat-wise population sensus conducted in the Project Area in 1970, because the latest data were not available after 1970. The agricultural population per household was estimated at around 2.2 persons on the basis of the working ages ranging from 15 to 64 years old.

3. 2. Natural Feastures

3. 2. 1. Meteorology and Hydrology

(1) Meteorology

The Project Area, located in the north of Thailand, has the savanna climate, which is specified into two seasons, the dry and the wet seasons that have been caused by the northeast monsoon and the southwest monsoon respectively. The wet season lasts from May to October and the dry season lasts from November to April. November and April are considered as the transitional months from the wet season to the dry season and vice versa judging from heavy yearly fluctuation of their monthly rainfalls.

The specific features of the climate of the Project Area are characterized by those meteorological factors of wind, humidity and temperature that affect rainfall, rainfall distribution and evaporation. The meteorological specific features observed at Lampang are shown in Table 1 of this Report.

(a) Temperature

The annual mean temperature at Lampang is 26°C, the mean maximum temperature is 37.0°C measured in April, and the mean minimum temperature is 13.5°C measured in January.

(b) Humidity

The annual mean humidity is 71 percent, the maximum humidity is 97.2 percent observed in October, and the minimum humidity is 31.6 percent observed in March. The annual fluctuation range is comparatively large.

(c) Wind

In the Project Area, the northeasterly wind blows gently with velocity at 1.7-1.9 knots October through January, while the south or southeasterly wind tends to blow as the wet season nears.

The highest wind velocity observed is 4.0 knots in June and July in the wet season.

(d) Evaporation

The observation of evaporation by evaporation pan has not been carried out at Lampang. According to the observation records by Piche evaporation meter, the maximum evaporation is measured by 122 mm in March and April when the temperature becomes highest in the year, while the minimum is measured by 41.3 mm in October.

(2) Hydrology

(a) Rainfall

In the Project Area, the annual rainfall measured by gauging stations at Lampang and its surroundings including Ko Kha, Mae Tha, Han Chat and Chae Hom ranges from 700 mm to 1,500 mm having a large annual fluctuation.

The annual mean rainfall in the Area is about 1,100 mm and about 88 percent of the total annual rainfall concentratively, take place in the wet season. The monthly mean maximum rainfall is 220 mm measured in August. A very little rainfall, covering

only two or three percent of the annual rainfall, occurs in the dry season lasting three months from December to February.

The rainfall in the Project Area has a shower type with covering only a considerably small area; hence, there is no correlations among the annual rainfall observed at gauging station even located in neighbouring areas. (ANNEX 1-1, Table 1-1-6)

The distribution of raining days has similar tendency to that of the monthly mean rainfalls; a period from August through September has the most raining days of the year - 20 raining days in a month, while the fewest raining days occur in February - only one day in a month. (ANNEX 1-1, Table 1-1-5)

The probable rainfall, which is one of the important factors for establishing an irrigation plan, is illustrated as below.

Minimum Probable Rainfall (mm)

Lampang 1952 - 1978

Return Period	Nov. - Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Year
5 years	71.8	83.7	69.1	75.6	162.4	161.6	69.3	918.7
10 years	54.6	64.1	52.1	59.2	139.0	138.4	56.1	835.9
20 years	42.8	50.4	40.3	47.9	122.5	120.4	47.1	770.3

The results of the consecutive rainfall analysis, which is required for determining the unit area drainage discharge for the Project Area, are shown as follows:

Consecutive Probable Rainfall (mm)

Lampang 1952 - 1978

Return Period	1 day	2 days	3 days	4 days	5 days
5 years	87.7	112.0	123.9	134.8	152.6
10 years	98.8	125.3	135.0	148.1	169.9
20 years	108.9	137.3	144.4	159.6	185.4

(b) River discharges

The observation of the river discharges of the Wang River basin in the Project Area has been carried out at Chae Hom, Kew Lom Dam, Kittikhachon II Bridge and Ko Kha Bridge, and at Ban Sop Po on the Chang River, one of the tributaries of the Wang River. However, the Long-term observation has been carried out only at Kittikhachon II Bridge (W.1). (ANNEX 1-1, Figure 1-1-1)

The river discharge observation at Kew Lom Dam - the irrigation water resources for the Project - has been conducted since 1962 and after dam completion in 1972 the intake and the release amount have been observed as well.

The annual runoff discharge commanded at dam site ranges from 350 MCM to 1,500 MCM with large yearly fluctuation. The annual mean runoff discharge was estimated at 698 MCM and the monthly mean was estimated at 168 MCM with monthly maximum in September. The minimum runoff discharge occurs in a period from February to April, occuping only about one to two percent of the annual runoff discharge.

The Sop Ang Diversion Dam located downstream of the Kew Lom Dam has diverted water at the constant amount of about 186 MCM on an average. (ANNEX 1-1, Table 1-1-12)

The total runoff discharges observed for long-term at the Kew Lom Dam site and Kittikhachon II Bridge and the specific discharges are shown below.

Gauging Station	Catchment Area (km^2)	Annual Runoff Discharge (MCM)	Annual Specific Runoff (mm)
Kew Lom	2,796	559	200
Kittikhachon	3,481	568 (754)	163 (217)

Notes: The annual runoff discharges have taken the values for 10 years (1962 - 1971), and the values indicated in the parenthesis are cited in considering the discharge of 186 MCM for diverted amount at the Sop Ang Diversion Dam.

The observation records at every gauging station are illustrated in Table 1-1-7~1-1-11, ANNEX 1-1.

3. 2. 2. Topography

The Project Area is the paddy field areas extending on the both banks of the Wang River with comparatively gentle slope. The area from the northern part to Lampang city dips with 1/100 - 1/500 from east towards west and the area along the Mae Wang Main Canal bounded by forests and waste lands with considerably steep slope. Among these areas, the Kew Lom area extending on the right bank of the Wang River with elevation 250 - 270 m is now under land reclamation, having hilly lands with intricated topography with steep slopes. And these hilly lands exist in the mixture of the paddy field with upland fields to present the more intricated topography.

The area from the south of Lampang city to the Chang River is formed by comparatively flat paddy fields with gentle slope excepting a part of some hilly lands The areas along the Wang River and arable lands extending in the southern part of the Project Area along the Pung River have slope ranging from 1/500 to 1/1,000 with elevation of 230 - 260 m.

3. 2. 3. Soil and Land Classification

(1) Geology and Landform

Almost entire Project Area lies with alluvium and old levees formed from recent or semi-recent alluvium are developed along Wang River and its tributaries. The semi-recent terraces are developed behind the old levees, and terraces or fan, being formed from old alluvium are situated on the area elevating about 240 - 250 m adjacent to the semi-recent terraces. Lampang Group[1/] is distributed near Kew Lom Dam Site.

(2) Soils in the Project Area

Flood plain (650 ha 7.7%) composed of Tha Muang series (sandy loam/silty loam) which is suitable for upland field and Sanphya series (loam/silty loam) which is suitable for paddy field, are developed in the upperstream area of the Wang River. The soils on semi-recent terraces (5,340 ha 30.3%) belong to Mai Sai and Hand Dong series. The former soils are poor drained silty soil distributing on flat land and the latter soils are moderately poor to good rained loam or clay loam occurred on flat to undulating land, both soils are suitable for paddy field.

Kampaheng Saen and Si Satchanali series are distributed on old levees (2,160 ha 12.0%), the former soils are good drained clay loam and mainly used for upland field and orchard. The latter soils are well drained silty or clayey soil distributed on flat to slightly undulating land, and they are usually used as the upland field.

The soils on old terraces (8,730 ha 49.0%) are mainly composed of Lampang, Roi Et and San Sai series that belong to Low Humic Gley Soil, and of Hang Chat and Satuk series that belong to Red Yellow Podzolic Soil. Fourteen soil series including the above soil series are distributed on old terraces in the form of soil series itself or its association.

Soil series of Low Humic Gley Soil are somewhat poor or poorly drained loam, sandy loam, clay loam or sandy clay loam. They occur on flat to slightly undulating

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1/ Marine and nonmarine sandstone shale and limestone folded-triassic by F.R. Moorman 1972.

low terraces and mainly used for paddy field. Soil series of Red Yellow Podzolic Soil are well drained sandy loam, sandy clay loam or sandy clay. They occur on undulating to gently rolling middle to high terrace and generally suited for upland crop farming.

(3) Soils in the Sample Areas

In general, the surface soils of every smaple area are moderately fine textured soil (clay loam/sandy clay loam). The surface soils in sample area No. 1, No. 2, and No.4 locating on the right bank of Wang River are moderately fine extured soil, however textured subsoils usually clay dominate with depth.

On the other hand, the soils in the sample area No.3 and No.5 on the left bank generally are moderately fine textured soil. The proportion of clay particles in soils sampled from test pits tend to increase with depth. (ANNEX 1-2, Figure 1-2-9)

The tendency of soil texture at 207 auger boring sites in paddy fields shows that 50 percent of the total has fine textured soil and 45.9 percent has moderately fine textured soil at 50 cm below the surface. From these facts, it appears that the paddy fields in the Project Area have slow to moderate permeability and also have relatively good water holding capacity.

The soils to 50 cm in depth from the surface in sample area No.3 and No.5 are almost sandy clay loam, and the occurrence of such a textured soils seems to be one of the reasons why the double cropping system are prevailed in the above two sample areas compared with other three sample areas.

Although the effective depth of soil is deep throughout the sample areas, layers with gravel, limestone fragment or pisolite occur in the limited areas. (ANNEX 1-2, Figure 1-2-5) Among them, gravel layers are found at 20 cm depth from the surface at the eastern corner of sample area No.5. These facts should be taken into consideration for the land consolidation program.

The soil reaction of every sample area is as shown in Table 1-2-4/5 and Figure 1-2-6. From these data it can be said that slightly to medium acid soil are widly distributed on the sample areas except for sample area No.4 having plenty of neutral soil. However, both the surface soil and subsoil having neutral or alkaline reaction are found 18 in sample area No.3 and 25 in sample area No.4. Among them, four in sample area No.3 and one in sample area No.4 have alkaline reaction, and particularly sample area No.3 has a site having strong alkaline reaction above PH 7.9.

As shown in Table 1-2-6, soils below 25 cm from the surface, has higher soil reaction (PH 7.6 - 8.1) and high content of sodium sulfate. From the gained value of exchangeable sodium percentage (above 15%) and electric conductivity (about 4 m mhos/cm), these soils seem to be the saline-alkali-soil[2/] and further detailed study will be needed.

In the general, it is hardly to define as the soils which are rich in available phosphorus, although there are the soils occurring above 45 ppm at places (ANNEX 1-2, Table 1-2-4 & Figure 1-2-7). The soils containing above 15 ppm (moderately high content) are 25 in sample area No.2, 3 in No.2, 11 in No.3, 12 in No.4 and 23 in No.5, and upland fields and paddy fields used for two paddy a year tend to have higher content compared with the other soils.

In sample area No.5 where double cropping on paddy field is prevailed than other areas, soils under the cropping pattern of rainy season paddy following tobacco cultivation during dry season, have an average available phosphorus of 21.9 ppm: in surface soil and 12.3 ppm in subsoil, while soils only used for rainy season paddy have 8.2 ppm in surface soil and 9.8 ppm in subsoil. These high contents in the former case are assumed to be the influence by applied phosphorus fertilizer to the tobacco cultivation.

According to the result of soil analysis, (ANNEX 1-2, Table 1-2-6) the organic matter content is generally low, particulary soils below 25 cm from the surface have low content below 1.0 percent.

Although the cation exchange capacity increases with depth, it is generally medium to moderately high capacity except in Sample area No.4. The content of nitrogen, available potasium and available phosphorus show low value.

From these results, natural fertility of subsoil is lower than that of surface soils, therefore when the existing surface soils are taken away for the land consolidation works, the present production level of crops can hardly be maintained on these lands for two or three years, unless much more organic materials (manure, compost) as well as fertilizers are applied to increase soil fertility.

(4) Land Classification

The land of Project Area, 22,700 ha was grouped by land class group as shown

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2/ Diagnosis and Implovement of Sarine and Alkali Soils, USDA. Hand Book 60.

in Table 2, 3 and Figure 1. According to the data on present situation of land use, acreage of paddy fields totaled in 12,300 ha and upland fields in 2,250 ha. In comparison with the acreage of lands classified as paddy field group, it appears that most parts of the lands classified as U2/R2* group are used as paddy fields.

Out of 6,773 ha of the present arable lands in the Zone No.3-7, 6,324 ha about 93.3 percent of the above, have been used for paddy production, while this acreage corresponds to 4,399 ha of R1/R3* group, 1,650 ha of U2/R2 group and a part of U1-U3 group. Under such circumstances, further reclamation of paddy fields will not be expected in the said Zones.

On the other hand, in the zone No.12, there are 1,353 ha of lands classified as paddy fields, while the existing paddy fields are 1,351 ha in total, and furthermore, there are the lands of 2,519 ha in U1-U3 group and U2/R2 group, while the existing upland fields are 1,590 ha in total. Therefore, the zone No.12 appears to have a room enough to develop the lands in U2/R2 group into the paddy field in future.

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* Note: Land Classification Classes by RID.

Class U1:	Land best suitable for upland irrigation crops.
Class U2:	Land less suitable for upland irrigation crops with one or more limitation in the soil, topography or drainage characteristics.
Class U3:	Land of distinctly restricted suitability for upland crops because of exgreme limitation in the soil, topography or drainage characteristics.
Class U2/R2:	Land suitable for either upland crops or rice production with some limitation.
Class R1:	Land best suited for rice production.
Class R2:	Land adopted for rice production but with one or more limitations.
Class R3:	Land districtly restricted for rice production because of extreme limitations.
Class 6:	Land unsuitable for the production of crops.

3. 3. Agricultural Situations

3. 3. 1. Land Use and Land Tenure

(1) Land Use

The land use in the Project Area varies in its types depending upon the location of lands against the Mae Wang canals or the Mae Pung canals; the lands located lower than these canals are used as paddy fields where paddy is grown in the wet season and paddy and/or upland crops are grown in the dry season. The lands elevated higher than these canals and those of surroundings of the villages are used as upland field and/or orchards.

Present Acreage by Land Categories in the Project Area

	Paddy field	Upland field	Orchards	Total (arable lands)	Forests	Villages Area	Total
Acreage (ha)	12,300	2,250	250	14,800	3,000	4,900	22,700
Ratio (%)	54.2	9.9	1.1	65.2	13.2	21.6	100.0

The crop-wise growing acreages in the Project Area are tabulated below based on the data prepared by RID's Mae Wang O & M Office and the field office of Department of Settlement, the Ministry of Interior. The map of present land use is presented in Map 1-3-1, ANNEX 1-3.

Present Cropping Pattern and Acreage in the Project Area

(Unit: ha)

	Crops	Wet Season	Dry Season	Total	Ratio	Remarks
1.	Paddy	12,300	472	12,772	71.5	
2.	Peanut	401	1,275	1,676	9.4	Cropping Intensity
3.	Tobacco	95	704	799	4.5	
4.	Soybean	144	462	606	3.4	$= \frac{17,860\ ha}{14,800\ ha} \times 100$
5.	Chilli	174	35	209	1.2	
6.	Garlic	0	531	531	3.0	$= 121\%$
7.	Sugarcane	200	200	200	1.1	
8.	Pineapple	100	100	100	0.5	
9.	Vegetable	346	371	717	4.0	
10.	Orchard	250	250	250	1.4	
	Total	14,000	4,400	17,860	100.0	

(2) Land Tenure

The Project Area includes three Amphoes, Muang Lampang, Mae Tha and Ko Kha. According to the data of the "Agricultural Land Tenure" prepared by the Land Development Department, MOAC, the agricultural lands and the number of farm households in Amphoe Muang Lampang are 23,367 ha and 17,522 households, respectively. 88 percent of agricultural land - 20,435 ha is operated by 93 percent of farm households - 16,243 households of owner farmers.

In Amphoe Mae Tha, 99 percent of agricultural lands is operated by 99 percent of farm households (owner farmer) and Amphoe Ko Kha, 97 percent of agricultural lands is operated by 98 percent of farm households.

The average farm size operated by one farmer is 1.3 ha in Amphoe Muang Lampang, 1.4 ha in Amphoe Mae Tha and 1.6 ha in Amphoe Ko Kha. However, the average farm size in the Project Area was estimated at about 1.3 ha because about 70 percent of the Project Area is covered by the area of Amphoe Muang Lampang.

3. 3. 2. Agricultural Practices

As stated in the previous section, average size of the farms of the Project Area is about 1.3 ha and evidently small in scale by Thai standard. Farmers, however, have practiced subsistence farming for generations, aided by comparatively high fertility of the land.

(1) Agriculture in the wet season

In the wet season which starts in May and ends in October, over 80 percent of the arable land is under paddy, most of which is meant for consumption of the farmers themselves. The remainder of the arable lands is occupied by fruit trees, sugar canes, pineapples, vegetables and so on. Paddy grown is predominantly glutinuous which is the staple diet of the people of the area. Nio Sanpatong is the main variety and nearly all the varieties and local one sensitive to photoperiod. Nio Sanpatong is reputed for its excellent palatability and its yield is comparable to improved varieties under conditions of no fertilizer application which is customary in the Project Area. This makes the introduction of improved varieties very difficult. At present, farmers sow the seeds in June to July, and transplant seedlings in July to August. Paddy is made ripe towards the end of November and harvested in December.

Sugar canes are harvested once a year, but new planting is done only once in four years. Pineapples are harvested at the rate of once in one and a half years. Both sugar canes and pineapples are grown in places where irrigation water is difficult to

obtain. Fruit trees and vegetables are grown mainly in the areas along the rivers, which are new alluvium and fertile.

(2) Agriculture in the Dry Season

Land scape of the area changes entirely with the beginning of the dry season which starts in November and ends in April. About 70 percent of the arable land is left fallow and only about 30 percent is under crops. The sort of crops grown is also entirely different. Peanut is predominant in acreage and followed by paddy, tobacco, garlic, vegetables and soybean in the decreasing order. The variety of dry season paddy grown is RD7 which is high yielding type and non-sensitive to photoperiod. Of tobacco and soybean, improved varieties are also grown, that is, Virginia Coker 187 Hick of tobacco and SJ4 of soybean. As for peanut and garlic, local varieties are chiefly grown but those introduced from Taiwan are also grown. Fertilizers are applied, though quite different crop by crop, in the amount applied.

Generally speaking, dry season cropping is progressive in comparison with the wet season cropping which is conservative. It is observed that farmers have been more receptive to the guidance of the government agencies related to agricultural improvement as far as dry season cropping is concerned. This is simply because dry season cropping was started in the recent years and farmers did not know much about it and they have had no choice but to follow the government guidance.

As for the planting time of various crops, tobacco and garlic are the first to be planted in December, followed by peanut and soybean which are to be sown in January to February and paddy is the last to be transplanted in March. Sometimes third crops are grown on the same site. They are usually peanut.

3. 3. 3. Agricultural Production

(1) Historical Change in Planted Areas of Various Crops

In olden times when there were practically no irrigation facilities, croppings were possible only during the wet season except for small patches of land directly adjacent to rivers and marshes. Therefore wet season croppings were practically the only one possible in olden times when people settled in this area for the first time. Even after the establishment of the irrigation facilities in the recent years to stabilize the wet season croppings they do not seem to have changed much. That is to say, farmers grown paddy wherever possible. This is simply because paddy is not only the staple diet of the people but also it is the agricultural product which can be cashed most easily and safely. Such crops as maize, sugar cane and tapioca which are the most important upland crops at the present time were not grown extensively just ten to

twenty years ago. Even after vast foreign market were developed for these crops, they have not been grown in the Project Area. This is because farmers have had to turn to more profitable crops, though they may be more labor-consuming, owing to the small size of their holdings. A relevant example for this is sugar cane cultivation. In the Central Plain, sugar cane production has been increased greatly in the recent years owing to the higher income to the farmers of the Central Plain. In the Project Area, however, sugar cane acreage has been steadily on the decline in the recent years regardless of the fact that there are two sugar mills within the Project Area. Sugar cane which requires one whole year to harvest is not profitable enough by the Project Area's standard.

Yearly change in planted acreage of various crops is thought to be the reflection of profitability of those crops in the area concerned. In this sense, yearly change in planted acreage of various crops other than wet season paddy, since 1962 to 1979, is presented in Figure 2.

As shown in this figure, dry season paddy and soybean cultivation was started in the recent years, but planted acreage has increased rapidly. On the other hand, sugar cane acreage has tended to decrease gradually. Tobacco growing was started much earlier than paddy and soybean and has increased steadily since then. Peanut and garlic were started to be grown earlier than tobacco, but due to violent fluctuatioin in market price, their planted acreage fluctuated greatly. Even so, peanut acreage is the biggest of all the dry season crops and garlic occupies fourth place as of 1979.

Wet season paddy occupies by far the largest area. Its planted acreage, however, has been declining little by little due to construction of houses, factories and roads, except for zone 12 where there is much room for reclamation thanks chiefly to irrigation water becoming available to shrub land by the construction of Kew Lom Canal.

(2) Yield per Unit Area of Various Crops

As for yield per unit area of various crops, there are several sources available, such as those of RID, DAE of MOAC and Agricultural Statistics of Thailand for which Division of Agricultural Economics of the Under Secretary's Office is responsible. In reviewing these statistics, it was felt that number of sample farms was too small to assess the average yield of the area of over 10,000 ha. For example RID survey result is based upon 20 farmers for wet season paddy and 10 farmers for dry season paddy. Accordingly, in the present study, a further survey was conducted and 100 farms were taken at random, and weighted average yield of wet season paddy of 100 farms were calculated. It turned out as follows:

Year	Number of Sample Farms	Sum of Planted Area (ha)	Sum of Production (ton)	Average Yield (kg/ha)
1976	44	48.16	136.874	2,842
1977	44	51.88	149.554	2,883
1978	97	138.62	392.485	2,831
Total		238.66	678.913	
Mean				2,845

Notes: 1. Concerning 1976 and 1977 yields, more than half of sample farmers were not sure and therefore their yields were not taken into account for those years.

2. Three sample farms did not grow paddy in 1978.

Concerning dry season paddy, only 19 sample farmers grew it. Their average yield was 2,365 kg/ha.

Quite different from the trend of other area, yield of dry season paddy was less than that of the wet season paddy. This is presumed to be due to the fact that dry season paddy culture is quite new to the farmers of the Project Area and some of the sample farmers grew dry season paddy for the first time and are not well versed in growing dry season paddy. There is much room for improving cultural technique of this crop.

Yield of wet season paddy is also lower than that of the survey result of RID. This is partly attributable to the inclusion of zone 12, many paddy land of which were recently reclaimed and are not mellow enough to be highly productive.

As regards yields per unit area of other crops, survey results of such agencies as RID, DAE and Changwet Office were not always consistent. Agricultural Statistics of Thailand Crop year 1977/1978 was also referred to. It was felt risky to depend solely on one source. Accordingly, referring further to the experimental results of the research organs, yields per unit area of various crops were assessed as follows.

Yield of Various Crops in kg/ha

Crops	Condition	Yield (kg/ha)
Wet season rice in paddy	air dry	2,845
Dry season rice in paddy	air dry	2,365
Peanut in shell	fresh	3,429
Tobacco Leaves	fresh	10,884
Soybean	air dry	1,499
Chilli	fresh	2,601
Garlic	fresh	4,772
Sugar Cane	fresh	28,607
Pineapple	fresh	13,311
Cabbage	fresh	7,969

Notes: Farmers of the Project Area sell their products of tobacco, chilli, peanut, and garlic in fresh forms. Weight ratios of fresh and air dry materials are as follows :

	Fresh	Air dry
Peanut	2	1
Tobacco	8	1
Chilli	3	1
Garlic	10	7

3. 3. 4. Commodities Necessary for Agricultural Production

(1) Agricultural Machinery

An average size of the farms of the Project Area is small. More than half of the farmers do not own a draft animal. At the time of plowing for which a draft animal is indispensable they hire one from one of the owners. Under these circumstances, they can not afford to purchase agricultural machineries such as a small tiller, which is much more costly. Nor is it necessary as their holdings are small. Threshing is also done by hand, in which bundles of earbearing straw are struck at the earth. As the results of agro-economic survey of 100 sample farmers in the Project Area indicated, however, 20 percent of total paddy field was cultivated using farm machinery by rental basis.

(2) Fertilizers and Chemicals

Generally speaking, low price of agricultural product makes various inputs less profitable. Application of fertilizers, nitrogen in particular, is small. For this reason, crops are hardy, and damages by insects and pests not frequent. Accordingly use of agricultural chemicals is also not frequent.

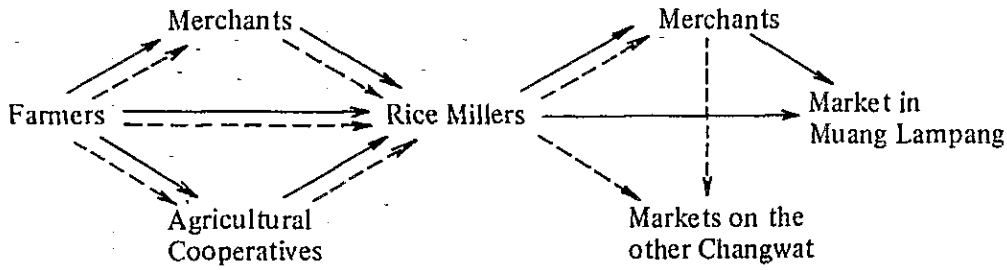
Harvest dose of fertilizers is applied to tobacco, by the guidance of Tobacco Monopoly. Formula is 4-16-24-4 (N-P_2O_5 - K_2O - MgO) and the rate ranges 450 to 780 kg per ha. Though little fertilizers are applied to wet season paddy, 95 kg per ha of Ammophos (16 - 20 - 0) is applied to dry season paddy, under the guidance of DAE. Fertilizers are applied also to garlics and pineapples. As stated earlier, dry season croppings are more progressive in this respect.

3. 3. 5. Marketing structure

Major farm products in the Project Area are paddy, peanut, garlic, tobacco and soybean. Paddy currently produced in the Area is mostly glutinous varieties grown in the wet season. Since the glutinous rice has high palatability in this region only, a very little of the product has been exported to the other Changwat and most of all glutinous rice produced is used for farm family consumption or consumed within the Changwat. Some high quality rice has been exported to other areas, mainly Bangkok through the hands of rice millers or merchants. The major crops other than paddy play a vitally important role in farm economy as cash crops with high commercial values, and trading of these crops is also made by quatamen, the merchants who are dealing with them in forwarding and selling the products.

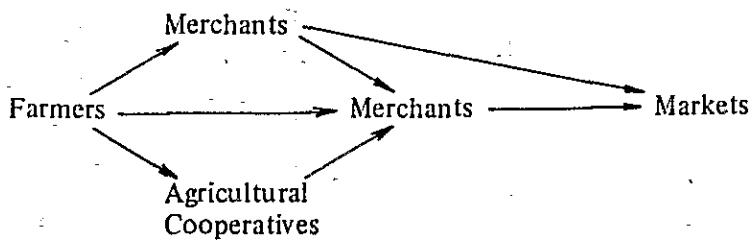
The crop-wise marketing channels are illustrated as follows:

Paddy

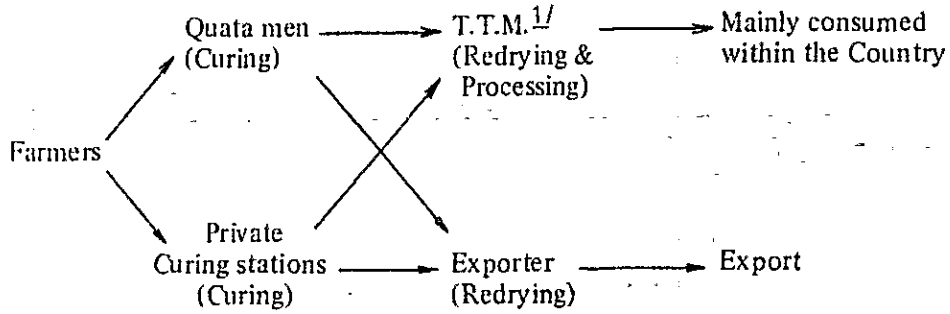


Note: ——→ Glutinous Rice, - - - → Nonglutinous Rice

Peanut, Garlic, Soybean



Tobacco



Note: 1/ T.T.M. = Thai Tobacco Monopoly

3. 3. 6. Agricultural Research and Extension

(1) Research

Within Changwat Lampang, there is only one agricultural experiment station. This is Lampang Horticultural Experiment Station. It was established in 1974 and holds 16 staff and about 300 ha of land. The said station is responsible for studies on vegetables, fruit trees and flower plants. One of the main objectives of the station is to find varieties suited to the area.

Within the Project Area there are no other experiment stations dealing with such major crops as paddy, peanut, soybean, garlic and so on. But in Chiang Mai which is about 90 km away to the northwest, there are Faculty of Agriculture, Chiang Mai University, Mae Jo Agricultural Experiment Station, and Sampatong Rice Experiment Station. To the south there is Sri Samrong Agricultural Experiment Station in Changwat Suckothai. These institutions are situated in places where climatic conditions are nearly the same as those of the Project Area. Experimental results obtained in these institutions must be applicable to the Project Area. Only difficulty expected is in relation to soil conditions. In the Project Area, the same soil is turned alternately into upland and lowland conditions. On the other hand in the above-mentioned stations, upland is used permanently as upland, and lowland permamently as lowland.

There is a Thai-Australian Land Development Project (TALD) team stationed in Lampang. But at present its main work is the land reclamation in Changwats Nan and Phrae.

As for the educational facilities, there is Lampang Agricultural College. It was established in 1972 and holds 40 teaching staff and 400 students of whom 20 percent are female. Overwhelming majority (95%) of the graduates of the school

become civil servants of the Government, both central and local, and the staff of the various agricultural enterprises.

(2) Extension

Agricultural extension of Thailand, since its reorganization in 1966, gradually began to reach the average farmers. However, owing to the shortage of staff and various facilities, it could not be said that DAE served the farmers well. With the introduction of dry season cropping, importance of agricultural extension was recognized and since 1977, with the aid of World Bank (IBRD), National Agriculture Extension Project was started. Thus, number of agricultural extension agents were greatly increased and facilities were improved. For example, number of agricultural extension agents for Changwat Office and those for three Amphoes within the Project Area were respectively increased to 18 and 49 persons.

These agricultural extension agents are to have regular meetings at fortnightly interval with the staff of agriculture-related organizations, such as Plant Protection Team, RID, Land Development Department, Animal Husbandry Department, etc. to exchange knowledge and to strengthen communications.

Each agricultural extension agent is responsible for 1,000 farmers and one farmer out of ten is designated as contact farmer who is to be the link between agricultural extension agents and farmer in general.

3. 3. 7. Agricultural Cooperatives and Crediting

In the Project Area, there are three agricultural cooperatives to cover the respecrive Amphoe. They are located in Amphoe Muang, Amphoe Ko Kha and Amphoe Mae Tha in the Project Area, performing the following activities.

i) Amphoe Muang Cooperative

The Amphoe Muang cooperative involves 60 farmers' groups for agricultural crediting. The total number of the member farmers counts 2,452 farmers, 1,536 farmers (for 34 groups) of which are those concerned with the Project. The crediting amount utilized totaled about 5.5 million Baht.

The cooperative has handled the input materials such as fertilizers, chemicals and animal feeds for sales, and paddy and peanut for procurement. The cooperarive has installed sorting machine of peanut (capacity: 600 kg/hr) to render sorting services for farmers from this year. The branch office of this organization has been situated in the Kew Lom area to serve the settler farmers in the area.

ii) Amphoe Ko Kha cooperative

The Amphoe Ko Kha cooperative involves 44 farmers' groups for agricultural crediting The total number of member farmers counts 1,973 farmers, 307 farmers (for 8 groups) of which are the project related farmers The credit amount totaled 1.36 million Baht.

In 1978 the sales results of farm input and equipment were 50 sprayers, 78 ton fertilizers for paddy, 26 ton fertilizers for sugar cane, and agri-chemicals in small amount, and 86 ton paddy was also handled by the cooperatives.

iii) Amphoe Mae Tha cooperative

This cooperative has rendered the crediting services for 18 farmers' groups containing 979 member farmers in total, 241 farmers (for 4 groups) of which are the Project related farmers. The total credit amount utilized was about 1.29 million Baht.

In agricultural crediting services, the Bank for Agriculture and Agricultural Cooperatives (BAAC) has a branch office in Lampang city playing a vitally important role to render the services in the line.

In compliance with the request from the Government, the commercial banks have made a policy to cooperate in serving for the agricultural crediting transactions. In the national level activities as well, the agricultural crediting services are still in premature in terms of organization and power.

The agricultural cooperatives, which are the foundation for encouraging the local agricultural development, should be brought up and strengthened to meet the requirements of the farmers concerned. The problems the cooperatives are facing are as follows;

1) The merchants intervene every transaction of forwarding, sales and marketing of all farm products to result in reducing the farmers net income.

2) Only about 17 percent of the entire farmers have been the member of the agricultural cooperatives, and the cooperatives have been functioning improperly as the service organization for farmers.

3) The cooperatives have provided insufficient staff and their working capacity is still inadequate to cope with the situation.

3. 3. 8. Farmers' Organization

The Mae Wang Project Area has provided the following farmers' organizations;

a) Groups formed under DAE guidance

b) Agricultural cooperatives

c) Groups established under BAAC guidance.

As water utilization groups, the Water Users' Association under the control of RID exists, although no People's Irrigation Association under control of the Ministry of Interior exists in the Project Area.

Besides the above, there are several groups existing under the guidance of Extension Office in the Project Area, such as the Youth's Group aiming at educating and training the farmers' successors and Housewive's Club aiming at teaching housekeeping arts such as sewing, cooking, etc.

The major activities exercised by the above groups and organization are as follows:

a) The farmers' group under DAE guidance

The groups are organized on the Tambon basis and the member farmers can have credit under the guarantee by group for purchase of land, farm machinery, animals, and for other farming works. Furthermore, the members can be preferentially supplied with farm input and technical guidance through the group concerned. The entry rate of farmers is about 10 percent in Amphoe Muang, about 20 percent in Amphoe Ko Kha and about 16 percent in Amphoe Mae Tha respectively.

b) Agricultural Cooperarives

The main purpose of this organization is to give agricultural credit to farmers through the organization, and the member farmers can purchase a variety of farm input material with the said credit. Their services also cover the procurement of paddy and peanut. The rate of entry is about nine percent in Amphoe Muang, about 22 percent in Amphoe Ko Kha and about 11 percent in Amphoe Mae Tha respectively.

3. 4. Irrigation/Drainage Systems and On-farm Conditions

3. 4. 1. Irrigation System

In the Project Area, the four main canals, i.e. Mae Wang left and right main canals. Mae Pung main canal and Kew Lom main canal, have been supplying the irrigation water to the respective beneficial areas. These main canals can be detailed as follows:

(1) Canal conditions

Mae Wang left main canal

This is an earth canal which was constructed about 40 years ago at the same time of construction of Sop Ang Diversion Dam. The original designed maximum capacity was 8.38 m^3/s and its total length was 38.4 km. The canal, however, has been damaged by erosion and collapsed on the slope due to being unlined, and the yearly maintenance cost has become considerably large.

Ten secondary canals branch off from this canal and every secondary canal has provided check gates made of wood. Four secondary canals (total 11.9 km) out of ten (total 22.0 km) have been completed in their improvement with concrete lining.

Mae Wang right main canal

The water had been diverted to this canal from the diversion works provided upstream of the Sop Ang Diversion Dam before the Kew Lom Dam was constructed. However, heavy sediment had forced the original water diversion point for about 4.0 m^3/s to shift to the point along the Kew Lom Canal 3.4 km downstream from the Dam after completion of the Kew Lom main canal. This canal, having capacity of 4.38 m^3/s and 38.77 km in total length, is an erath canal as well and has been suffering from erosion and spoil dump of the embankment slopes. The 14 lateral canals branch off therefrom and their total length is 28.2 km (including sub-laterals). Twelve laterals of them have been improved in concrete lining for 22.8 km in length.

Mae Pung main canal

The Mae Pung main canal was constructed about 30 years ago in order to introduce the surplus water of the Mae Wang Left Canal to the downstream areas, having capacity of 2.61 m^3/s at the diversion point. The 1.2 km long culvert (1,000 mm pipe), however, is provided from the point of KM 5 + 610 by open-cut at the high elevated portion; hence, the capacity is considerably small about 1.0 m^3/s. This is a bottleneck in supplying sufficient water to the Mae Pung area, causing a water shortage therearound.

The Mae Pung main canal is divided into two at the terminal, the left and the right main canals, having six laterals with total length of 20.6 km. One of the six laterals, extending 4.5 km, has been improved in concrete lining.

Kew Lom main canal

The Kew Lom Main Canal is a concrete-lined canal with capacity of 25.0 m^3/s to meet the water requirements involving Kew Lom Stage II and III area in considering the construction of the planned Kew Kor Mah Dam in the upstream of the existing Kew Lom Dam. The Kew Lom Main Canal is planned to reach the Kew Lom Stage II area with 40.8 km in total length, branching off the Mae Wang Right main canal and releasing the water of about 4.0 m^3/s. This canal constructed so far extends 35.0 km. In the Project Area, this main canal to supply the water to the Kew Lom Stage I area extend 23.8 km in length, branching off 19 concrete-lined laterals with 41.5 km in total length (including nine sub-laterals). The total length of the respective main and lateral canals are shown in Table 1-4-1, ANNEX 1-4.

(2) Present Irrigation Conditions

Mae Wang Left and Right Main Canals

In general, the irrigation conditions are favourable excepting for some fields along the canal route, locating higher than the full water level in the main canal. These fields are supplied with water introduced by farmers themselves. However, the check facilities across the laterals are so insufficiently provided that some farmers place wooden logs in the canals to raise the water level for water intake, and such temporary measures should be improved for more effective water supply.

Mae Pung Main Canal

As mentioned previously, an insufficient canal capacity and dependency on surplus water of the Mae Wang left main canal have caused water shortage resulting in delayed farming works as compared with those in the Mae Wang area, particularly in the southern part of the commanded area by the canal, and paddy transplanting is delayed one or one and a half month to the ordinary schedule.

Kew Lom Main Canal

Since the laterals, providing many drop works against steep topography, can secure a sufficient water heads and the Kew Lom main canal has not been completed yet, the water is supplied to abundantly to its irrigation area that the surplus water is diverted to the Mae Wang right main canal. Such sufficient water available has enabled to promote steadily the land reclamation in the related area. However, some newly reclaimed lands located higher than the canal water level requires to provide supplemental irrigation facilities for water supply.

3. 4. 2. Drainage System

In the Project Area the streams and waterways function as the drainage canals, and only improvement has been made on the drainage courses around structures provided there, such as syphones and bridges to cross over the roads and other canals.

(1) Drainage System in the Project Area

In the northern areas from Lampang city, the short distance between the Wang River and both main irrigation canals, the Mae Wang left and the Mae Wang right, and the steep topography can keep the area free from long-lasting ill-drainage.

In the southern areas from Lampang city, two streams of the Poon River and the Pung River function as main drainage canals. However, the Poon River, which is also utilized as irrigation canal for the Mae Poon area (Zone No. 7), has caused ill-drainage due to five weirs provided in the course, and there have been some swamps observed at the place where the terminal of the Mae Wang left main canal crosses over the Poon River. The Pung River, which runs through the centre of the Mae Pung area, has caused no ill-drainage at present.

(2) Drainage system outside Project Area

The runoff outside the Project Area is drained to the Wang River through small streams after it inflows into respective main irrigation canals running in parallel with the Wang River along the hillfoot.

The main natural drains, which drain the water out directly into the Wang River, extend in six routes, out of which four routes are located in the Mae Wang left bank area and the remaining two routes are located in the Mae Wang right bank area, respectively.

There are several syphon structures with waste-way facilities in main canal system and excess water from outside area are drained out by these structures.

The high-elevated areas in the Kew Lom area are drained by about 35 drainage culverts and the drained water flows down to the Mae Wang right main canal through the Kew Lom area. Only several inflet works are provided with for the purpose.

3. 4. 3. On-farm Conditions and Related Facilities

The Project Area, as mentioned already, can be roughly divided into three sub-areas, the Mae Wang, the Mae Pung and the Kew Lom areas.

The northern part and the central part of the Mae Wang area dip rather steeply at right angle to the Wang river course, whereas inclines gently from north to south in parallel with the Wang River to form a paddy field area. The on-farm facilities in the said area are the farm ditches linking with the diversion facilities provided at every main and lateral canals concerned. The farm ditches, however, are provided so sparsely that most of the fields are irrigated by plot-to-plot method which results are being difficult in stable water supply in the dry season.

Most of the ditches dually function for irrigation and drainage, and only in some low-lying lands, the farm drains are provided. Each plot has small size so as to meet the topographical conditions and no land consolidation works have been implemented.

In some parts in the south of the Area, intake weirs are provided in the farm drains to divert the irrigation water and thereby, inundation has taken place in the wet season, although small in scale. Almost no road facilities are provided in the area in relation to inadequate provision of other on-farm facilities.

In the Mae Pung area, lack of sufficient water resources has sometimes caused water shortage for puddling water and delay in paddy transplanting not only in the dry season but also in the wet season in the drought year. The topographical conditions in the area are more favourable to farming than those in the Mae Wang area, but the irrigation/drainage facilities are more inadequately and thinly provided than those in the Mae Wang area. Under the situation of the fields most of which are the rainfed fields, provision of main facilities and securing the sufficient water resources are urgently required as well as provision of on-farm facilities and land consolidation works are required.

The Kew Lom area is the newly reclaimed are in the beneficial area of the Kew Lom main canal under the Settlement Programme mentioned later. At present the farm land formation has been carried out by the farmers' own efforts together with construction of the farm ditches. This development based on irrigation facilities has resulted in thinly provided drainage facilities. However, the intricate topographical condition can be utilized to establish a drainage system in the use of fallow lands as drains. The existing and planned roads networks under the Settlement Programme have been well arranged as compared with those in other areas.

Although the lateral irrigation networks already provided by RID have rather high density, the comparison of the water level in the laterals and the elevation of the expected benefitial areas suggestes that the area to be covered by gravity irrigation

will occupy about 60 to 70 percent of the total cultivated lands Therefore, a further study on arrangement of the irrigation networks should be made to expand the beneficial areas.

3. 4. 4. Operation and Maintenance

(1) Water management organization

Operation and maintenance (O & M) office

The O & M offices for the Mae Wang and the Kew Lom areas belong administratively to the Regional Irrigation Office II, RID, and they are located at Sop Ang Diversion Dam Site and Kew Lom Dam site, respectively. The organization charts concerned are illustrated in Figure 1-4-1, ANNEX 1-4.

In the Mae Wang O & M office, one chief engineer adminsterand two water masters who are responsible for controlling operation of head regulators, check gates, etc., for the left and right main canals, respectively. The water master supervise 11 zonemen who are in charge of controlling operation of the facilities for the respective lateral canals. The water control at on-farm level is carried out by common irrigators.

According to the areas commanded by 11 zonemen, the Mae Wang area can be divided into 11 zones from zone No.1 to No.11: however, the zone No.11 is located outside the Project Area and the Project related zones count 10, from No.1 to No.10. In addition to the said 10 zones, the Kew Lom area can be included in the Project Area as zone No.12 and the total number of the zones becomes 11. The details in zoning of the Project Area are shown in Figure 1-4-2. ANNEX 1-4.

Water Users' Association

The Water Users' Association, which was nationwidely established by RID in 1970, has its four unit groups in the Project Area Their respective coverages and number of entries are tabulated as follows :

	Association Name	Area ha	Member persons	Location
1.	Ke Lang Patana	3,616	1,300	Right Main Canal
2.	Lan na Samaki	6,732	1,886	Left Main Canal
3.	Mae Pung Patana	2,428	1,320	Mae Pung Right Canal
4.	Patan Samaki	2,944	969	Mae Pung Left Canal
	Total	15,720	5,475	

The Water Users' Association in the whole irrigated farming areas throughout the country has not been so active in practical works.

(2) Operation and maintenance of facilities

The O & M offices have been in charge of operation and maintenance of main and lateral canals and their attached structures. There are two types of canals constructed in the Project Area, concrete lined canals and earth canals. For the earth canals, repair works to adjust the canal section have been made by two druglines every year before starting irrigation services. Furthermore, some old wooden bridges have been replaced with concrete ones and concrete lining has been implemented on the part of canals for providing the structures like stop-logs. As mentioned above, the improvement works have been executed slowly but steadily in the Project Area.

(3) Present Water Management

The O & M of the main and lateral canals, as mentioned previously, is carried out by 11 zonemen. Gates are installed at every diversion point from the main canals to the laterals, and also staff gauges are provided for measurement. Insufficient water-tightness of gate leaves, however, seems to cause error to given discharge or leakage when the discharge control or complete shut-down of the gates are required.

Furthermore, at every diversion site, check gates are installed across the main canals; however, the check gates have such simple structures with logs set up that it is difficult to secure successful and stable water level control.

Time-worm wood-made gates of waste ways, which are provided with at every syphon as attached structures, have caused heavy leakage to make a considerable amount of loss in discharge. These are only a few problems existing for improvement as mentioned above in the operation and maintenance of the main canals.

Sub-laterals or farm ditches are branched off from the lateral canal. Since, however, the lateral canals provide no check structures, there have been wooden logs put in the canals in some places for raising the water level. Except for the case of plot-to-plot irrigation, the on-farm facilities are in general inadequately provided and the water in the farm ditches is dammed up to be diverted to the fields.

3. 5. Other Development Schemes Relating to the Project

3. 5. 1. Settlement NIKOM) Project

The Settlement Project was approved on 13 April, 1969 under the order of the Minister of Interior so as to relieve 765 families which were transfered from the submerged area in the Kew Lom Dam construction and 178 local landless families.

This project area is located in the zone No. 12 of the MK-IADP, covering about 3,200 ha (20,104 rai), about 50 percent of which is involved in the MK-IADP. The planned land use contains the areas to be developed for farm lands of 2,263 ha (14,145 rai), for residential lots of 321 ha (2,007 rai), and the forest lands of 514 ha (3,213 rai) and the public lands of 115 ha (721 rai). Among the above, about 1,700 ha farm lands have been already developed. The settler families of 943 involving 4,904 persons have been distributed into 17 villages and the construction of public facilities as well as the land reclamation by farmers themselves have been now underway. These inhabitants produce paddy, maize, peanut, pineapple and pulses in the Project Area and the yearly gross income by these productions reached about seven million Baht in 1978. The average yearly gross income per family was estimated at about 10 thousand Baht. In addition, the settlers gain the income of 2.7 million Baht by animal husbandry and other production activities.

The investment to public facilities such as roads, farm ponds, school buildings, temple, etc. amounted to about 9.5 million Baht for seven years between 1972 and 1978. On top of the above, various services have been rendered in agricultural extension, crediting, training for farming machine operation, etc. Under the situation it is anticipated the settler farmers will execute in future more stable farm management than the existing farmers in other areas.

3. 5. 2. Lampang City Planning Project

This scheme aims at urban area development for about 2,900 ha located around Lampang city according to the City Planning Act enacted in 1975. The planned development area is situated in the centre of the MK-IADP Area.

The proposed land use in the area was studied based on the blue print prepared by the Ministry of Interior and the Lampang City Authorities, and the results are shown as follows:

Land Categories	Acreage ha
City & village area	1,462
Roads, rivers, etc.	87
Forest and waste lands	17
Sub-total	1,566
Paddy fields	1,276
Upland & orchards	61
Sub-total	1,337
Total	2,903 ha

The areal plan of the scheme is formulated in due consideration of the location of existing town area, peripheral villages, rivers, roads, airport and other public facilities. The implementation program is made on the long-term basis for the land use, areal division, and so on to keep a harmoney with the peripheral areas.

The areal division includes residential area, commercial area, public utilities area, parks and amusement centre, suburban farm villages, and suburban agricultural land area.

About 1,300 ha of farm lands involved in the MK-IADP are covered by this scheme as mentioned before, and these areas are most favoured with economical, social and natural conditions in the MK-IADP. This scheme will be realized by staging development in starting with implementation for the surroundings of the existing town area and major trunk roads. The farm lands involved in the initial stage of city development plan should be carefully studied for their consolidation in taking into account the progress of this scheme.

Table 1. Lampang Climatological Summaries

Period 1951 – 1975

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Temperature (°C)													
Mean	21.5	24.1	27.5	29.8	28.9	28.0	27.6	27.1	26.6	25.9	24.1	21.5	26.0
Mean Max.	30.1	33.2	35.8	37.0	34.9	32.8	32.2	31.7	31.5	31.2	30.5	29.4	32.5
Mean Min.	13.5	15.1	18.7	22.3	23.9	24.0	23.7	23.4	23.0	21.7	18.4	14.7	20.2
Relative Humidity (%)													
Mean	66.0	61.1	55.0	56.0	69.0	75.0	75.0	79.0	81.0	80.0	77.0	73.0	71.0
Mean Max.	95.9	92.1	86.9	85.7	91.1	93.2	92.9	95.1	96.6	97.2	97.0	96.6	93.4
Mean Min.	42.3	34.1	31.6	35.6	50.8	60.4	62.4	65.9	67.8	64.9	56.7	49.8	51.9
Dew Point (°C)													
Mean	15.1	15.4	16.6	19.7	22.7	23.4	23.2	23.6	23.7	22.7	20.0	16.6	20.3
Evaporation (mm)													
Mean - Piche	66.4	86.8	122.5	121.2	86.8	64.3	62.3	49.1	38.9	41.3	43.7	51.8	835.1
Wind (Knots)													
Prevailing Wind	N.S.	S	S	S	S	SW	SW	S	S	NE	NE	NE	–
Mean Wind Speed	2.3	2.6	3.0	3.7	3.5	4.0	3.9	3.4	2.2	1.9	1.7	1.9	–
Cloudiness (0 - 8)													
Mean	2.7	2.2	2.4	3.4	5.4	6.4	6.8	6.9	6.3	5.2	4.0	3.4	4.6
Rainfall (mm)													
Mean	6.4	6.2	28.9	63.2	152.6	137.6	131.3	215.7	210.8	122.0	26.6	5.7	1,107.0
Mean rainy days	1.4	0.9	3.1	6.2	13.9	15.9	17.7	20.3	18.4	12.0	3.7	1.7	115.2

Data source: Meteorological Department

Table 2. Acreage of Land Class Group

Land Class Group	Acreage (ha)	%
U1	2,290	10.1
U2	690	3.0
U3	140	0.6
Upland field sub-total	3,120	13.7
R1	7,290	32.1
R2	170	0.7
R3	940	4.2
Paddy field sub-total	8,400	37.0
U2/R2	4,040	17.8
U6/R6	2,240	9.9
Village & residential area	4,000	17.6
Others	900	4.0
Total	22,700	100.0

Note: Land Classification Classes by RID.

Class U1: Land best suitable for upland irrigation crops.

Class U2: Land less suitable for upland irrigation crops with one or more limitation in the soil, topography or drainage characteristics.

Class U3: Land of distinctly restricted suitability for upland crops because of extreme limitation in the soils, topography or drainage characteristics.

Class U2/R2: Land suitable for either upland crops or rice production with some limitation.

Class R1: Land best suited for rice production.

Class R2: Land adopted for rice production but with one or more limitations.

Class R3: Land distinctly restricted for rice production because of extreme limitations.

Class 6: Land unsuitable for the production of crops.

Table 3. Specification for Semi-detailed Land Classification

Mae Wang Project

Classification Characteristics	Upland			Rice-land		
	U-1	U-2	U-3	R-1	R-2	R-3
Soil Texture	SL-fri. CL	CLLS-p.C LS 30cm	LS - sp.C LS 60cm	CL-vsp.C CL 30cm	SL-vsp.C SL 15cm L 30cm CL 30cm	LS-sp.C LS 15cm
Depth to compacted horizon	150 cm	120 cm	90 cm	90 cm	60 - 90cm	30 cm
pH	5.5 - 8.5	5.0 - 8.5	4.5 - 8.5	5.0 - 8.5	4.5 - 8.5	4.0 - 8.5
Salinity EC x 10^3	4	6	8	4	6	8
Exchangeable Sodium meg/100gm	2	2	3	3	4	4
Water-holding capacity in 120cm depth	15 cm	11 cm	8 cm	not applicable	not applicable	not applicable
Topography	smooth	wavy	undulating	smooth	wavy	undulating
Slope	2%	4%	6%	2%	4%	4%
Levelling Requirement	Low	medium	high	low	low	medium
Gravel or Rock	few	few	some but tillable	few	few	some but tillable
Rock Removal	none	none	some	none	none	some
Trees or brush	slight	moderate	heavy	slight	moderate	heavy
Cover	clearing	clearing	clearing	clearing	clearing	clearing
DRAINAGE						
Surface	excellent	good	good	good	fair	fair to poor
Sub-surface	good	good	fair	poor	fair	good
Flood	no	no	occasional	infrequent	periodic	annual

Class 6 is the lands which the soils do not meet minimum requirements for other land classes.

Figure 1. Land Class Group Map

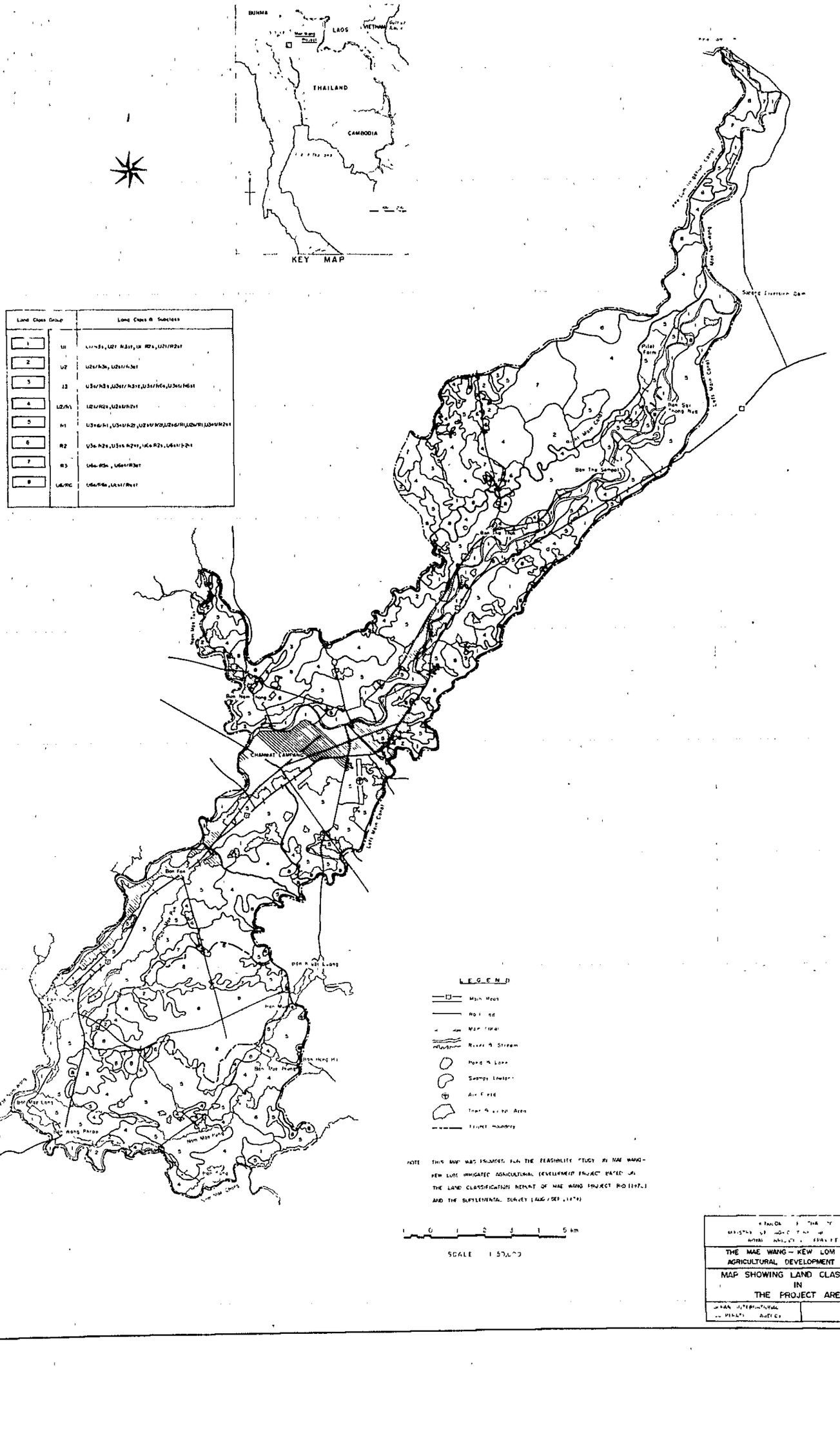
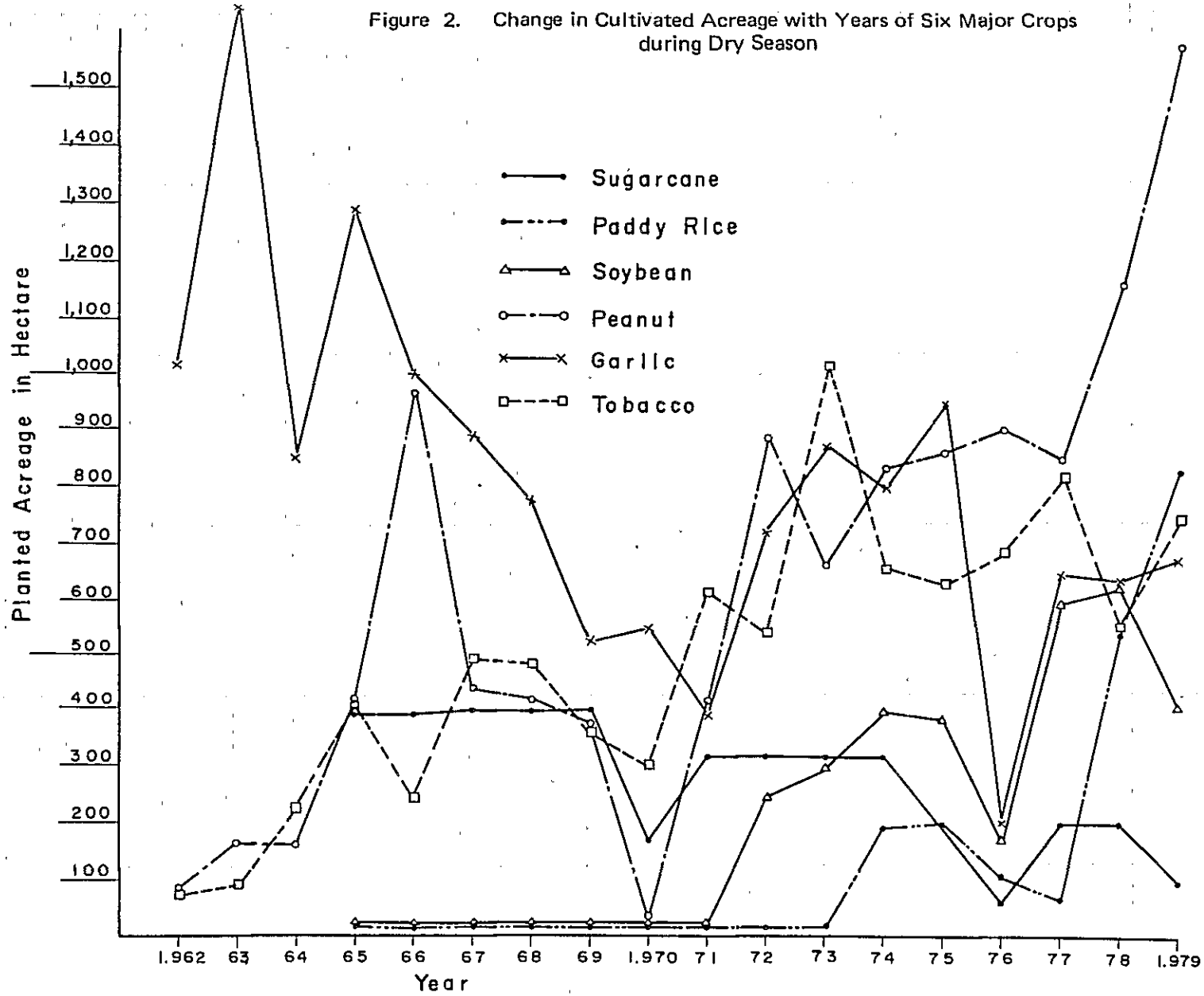


Figure 2. Change in Cultivated Acreage with Years of Six Major Crops during Dry Season



CHAPTER IV THE PROJECT

CHAPTER IV THE PROJECT

4. 1. The Purpose and Components of the Project

The Project aims at improvement and consolidation of farm lands as well as improvement and construction of farm facilities for encouragment of local agriculture through establishing a double cropping system and effective water resources utilization.

Practically, the Project plans (a) to most efficiently use of water stored in the Kew Lom Dam and other dams to be constructed in the Wang River Basin through their systematic operation and to establish an effective irrigation system to meet the requirements of the beneficial areas, (b) to construct and/or improve the main irrigation system in due consideration of the water utilization plan so that a stable water supply can be secured for the currently rainfed fields in the wet season, the cropping intensity in the dry season can be increased and a successful operation and maintenance system can be established, and (c) to implement land consolidation including improvement of on-farm facilities for introducing the double cropping system with paddy and upland crops as well as improved farming practices for stabilizing the farm economy.

In order to accomplish the aforesaid purposes, the plan is formulated on the basis of the following project works.

i) The main and lateral canals and related appurtenant structures will be constructed or improved for supplying a necessary amount of water to the farm ditches, and water control facilities such as check structures, regulators, etc. will be provided for proper water distribution by advanced water management techniques.

ii) The main drainage facilities will be constructed or improved to provide better conditions for introducing upland crops and HYV paddy.

iii) In addition to the consolidation of the main irrigation/drainage facilities, the farm ditches/drains and roads will be constructed. Land levelling with plot-rearrangement will be made, if necessary, for providing the better conditions for introducing the more intensive farming.

iv) The O & M roads along the main and lateral irrigation canals will be constructed or improved for carrying out effective operation and maintenance services. Furthermore, the O & M offices will be reinforced in staffing and equipping with necessary machines and equipment for maintenance services.

v) The agricultural supporting services to improve the agricultural infrastructure will be strengthened in close coordination among various agricultural research institutions and government agencies in and around the Project Area for upgrading the agricultural production and living standard of the beneficiary farmers. For this purpose, an execution program including expansion of facilities is proposed in taking into account the works to be required in the Project implementation and the post project, if necessary.

vi) A socio-economic monitoring and evaluating system for the expected project impacts to the socio-environment is proposed for making a basic policy of the agricultural supporting services, and also the work program of monitoring and evaluation will be made in compliance with the developing stage of the Project.

4. 2. Outline of the Project Planning

4. 2. 1. Proposed Land Use

The present and the proposed land use was studied to be shown as follows on the basis of the data available for the present land use and land classification for the Project Area.

(Unit: hectare)

Land Categories	Present Land Use	Proposed Land Use		Area included in the Lampang City planning Project
		Gross Area	Project Area	
Paddy Fields	12,300	13,400	12,445	955
Upland Fields	2,250	1,750	1,739	11
Orchards	250	250	244	6
Sub-total	14,800	15,400	14,428	972
Forests	3,000	2,400	2,400	0
Residential lots	4,000	4,000	2,989	1,011
Roads & others	900	900	848	52
Sub-total	7,900	7,300	6,237	1,063
Total	22,700	22,700	20,665	2,035

The lands suitable for paddy fields and for upland fields amount to 8,400 ha and 3,120 ha, respectively, and suitable dually for paddy fields and upland fields amount to 6,280 ha. In the present land use, about 43 percent of those lands suitable for upland, and upland or paddy fields have been utilized as paddy fields. And the

proposed land use was prepared based on the above fact as well as estimation that about 1,100 ha would be converted into paddy fields in future from the forest lands and uplands when the gravity irrigation can be assured in the settlement area; hence the total proposed paddy fields was estimated at 13,400 ha. The orchards, which are sporadically located around residential area except for some collective undertakings in the northern part of the Project Area, would remain in what they are at present.

In the Project Area, there are some lands involved in the Lampang City Planning Project and the above 2,035 ha out of the total 2,900 ha would not be newly invested for land improvement but only some for irrigation water supply.

4. 2. 2. Proposed Cropping Pattern

In planning a cropping pattern, it does not make sense to increase the acreage of various crops at the same rate. Various factors must be taken into consideration, such as expected demand in future, labor distribution in cultivation, transportation to the market and, as a special case, quote system of tobacco enforced by Tobacco Monopoly.

On the other hand, soils of the Project Area is generally loamy in texture and therefore practically every kind of crops can be grown. In taking into consideration the above factors, the proposed cropping pattern for the Project was so prepared that the wet season pattern would have almost the same as the present one and the dry season pattern would involve about 30 percent of paddy cropping and about 50 percent of upland crops respectively. The details are illustrated in Table 4 and Table 2-1 ~ 2-5 and Figure 2-1 in ANNEX 2.

The reason why the major crops are chosen for the cropping pattern is mentioned below.

(1) Rice

At the present time, only the glutinous rice is grown during the wet season and the non-glutinous during the dry season. The glutinous rice is meant for farmers' own consumption. If there is any oversupply of the glutinous rice, farmers can easily turn to non-glutinous rice. As for the non-glutinous, as the forecast of the Asian Development Bank indicates, there will be no oversupply of it in the world market in the foreseeable future, especially so for Thai rice. Because its international competitiveness is remarkable both in quality and price. Technically speaking, paddy is one of the easiest crops for the Thai farmers to grow. For these two reasons, biggest expansion in acreage was planned for this crop. That is to say, acreage will be ten times of

the present for the dry season paddy, and for the wet season paddy, about 80 percent increase in acreage in zone 12 where there is much room for reclamation but no change in the remaining 10 zones where there is practically no room for increase.

(2) Peanut

Area under peanut is the second biggest in the Project Area at present and as it has been grown for a long time, farmers are good at growing it. As it will be shown in relation to Chapter 4. 3. 1, peanut in this area grows well without phosphate application. This is presumed to be the reason why peanut has been grown widely in this area. Furthermore, whilst in other peanut growing area it should be grown during the wet season, it can be grown during the dry season thanks to irrigation. This greatly diminishes the damage by Leaf Spot Disease due to Cercospora Spp which infest this crop during the wet season.

From the view point of marketing, its future is bright, as export is possible and the Thai Government is going to encourage oil seed industry which will greatly increase the domestic demand.

After peanut, wet season paddy is usually grown without fertilizer. Stems and leaves of peanut should be precious manure for paddy. For these reasons, 100 percent increase in peanut acreage was planned.

(3) Soybean

Merit of growing soybean in this area is nearly the same as that of peanut. From the viewpoint of soil conditions also, the area is suitable. From the viewpoint of marketability, there is a vast demand in the world market. Recently a new variety called SJ 4 was released from Mae Jo Station. Seed of this variety is bigger than those of SJ 1 and 2 which are thought to be too small for international market. The said new variety is also resistant to rust disease caused by Phakospora pachyrrhizi which is the most dreaded disease of soybean. Soybean acreage has been increasing in recent years. Assisted by the introduction of new varieties, further increase is expected. Accordingly, 100 percent increase in soybean acreage is proposed.

(4) Tobacco

Under the guidance of Thai Tobacco Monopolym, tobacco culture was a progressive one in the choice of varieties and cultural practices. Safe income was also assured. Therefore, acreage under tobacco has steadily increased. However, this crop holds two difficulties. One is quota system enforced by Tobacco Monopoly, which allows for gradual increase in acreage under tobacco. The other is related to labor

distribution. To obtain a good quality tobacco leaves, seedlings must be planted long before December when paddy is harvested and tobacco is actually planted. Both must be finished, therefore, as quickly as possible. Hence temporary labor shortage occurs. So long as quota system is at work, big increase in tobacco acreage is impossible. Accordingly, it was planned that tobacco acreage during the dry season will be increased by 20 percent by the end of the project operation. Outside the said plan, it was also planned that 322 ha of land which is under upland crops during wet season at present will be devoted to growing good quality tobacco leaves for export. In this case, tobacco seedlings must be transplanted in July to August so that leaves can be harvested the early part of the dry season.

(5) Garlic

Garlic is the special product of the northern region due chiefly to comparatively cold dry season and loamy soil. The Project Area is suited to growing garlic. Demand for it is stable as it is an essential ingredient of every kind of Thai food. Export is also possible, but at present supply is not enough even for domestic demand, and some garlic is imported. Such being the case, 100 percent increase in garlic acreage is proposed.

(6) Chilli

The Project Area is noted for chilli production. Chilli is quite a profitable crop if grown under good care. Though there is some export of chilli, on balance import is bigger than export. Demand for chilli is stable at it is essential for every kind of Thai food. Accordingly big increase in chilli acreage is proposed.

(7) Sugarcane

Sugarcane acreage has been on the decline. The crop is not profitable enough in view of the fact that there are two sugar mills in the Project Area and cane growers have no difficulty to sell their product. It is expected that there will remain some area which is not irrigable even after the completion of the Project. Sugarcane is drought resistant comparatively and therefore must be suitable to such unirrigable area. Present sugar mills must be kept in operation. All these taken into account, present acreage is proposed to be maintained.

(8) Vegetables

Bangkok is the greatest consumer of fresh vegetables in Thailand. It has highly skilled vegetable growers in its suburbs, however. The Project Area is 650 km away from Bangkok. Accordingly, even if the Project Area can produce a good quality fresh vegetables, its products can not favorably compete the growers in the Bangkok

suburbs owing to high cost of freight charges, and the possibility of decay during transportation. But labor-intensive products are necessary for the Project Area to offer cash income to the farmers.

To replace fresh vegetable as cash supplier, it was proposed to grow garlic and chilli which, when dried, cost much less in freight and practically free from decay during transportation. As for the increase of vegetable acreage, only 10 percent was proposed. This is to cope with the demand increase in the city of Lampang.

The plans mentioned above can be tabulated in Tables 2-1 to 2-5, ANNEX 2.

4. 2. 3. Water Resources and Irrigation Planning

(1) Water resources

The water resources of the irrigation in the Project Area depend on the Kew Lom Dam across the Wang River, and the intake facilities are the Sop Ang Diversion Dam downstream the Kew Lom Dam. The Kew Lom Dam, completed in 1972, is of concrete gravity type with 110 MCM of effective storage capacity.

A construction plan of five dams including the Kew Lom Dam has been prepared for further irrigated agriculture development of the Wang River Basin around Lampang city. The construction plans of the Kew Kor Mah and Mae Chang dams are relating to this MK-IADP.

The proposed Kew Kor Mah Dam will be constructed upstream the Kew Lom Dam and these two dams will enlarge the irrigable area from existing 18,000 ha to about 37,000 ha in the Wang River Basin including Project Area by more effective utilization of the above two water resources. The existing Kew Lom canal is constructed with sufficient capacity to cover the irrigable areas to be expanded in future as well.

The Mae Chang Dam will command in future the total irrigable area of about 16,000 ha including a part of the Mae Pung area comprised in the MK-IADP Area, although the said Mae Pung area is currently irrigated by the water supplied from the Kew Lom Dam and the Pung River which flow down in the area.

The irrigable areas in the Project, however, will have been supplied with water from the Kew Lom Dam untill completion of these dams under contemplation by RID. (ANNEX 3-1, 3.1.1.)

(2) Irrigation plan

(a) Proposed irrigable area

The zone-wise irrigable areas estimated on the proposed land use are shown as follows:

Proposed Irrigable Area[1/]

(Unit: ha)

Name of Tract	Zone	Paddy	Upland	Total
Mae Wang Left	1, 2, 3, 4, 7.	4,829	426	5,255
Mae Wang Right	8, 9, 10.	2,573	238	2,811
Mae Pung	5, 6.	2,781	182	2,963
Kew Lom Stage I	12.	2,279	1,013	3,292
Kew Lom Stage II[2/]	—	2,656	528	3,184
Total		15,118	2,387	17,505

Notes: 1/ The respective irrigable areas are obtained by multiplying 0.93 for deduction rate of 7% for public facilities space after land consolidation works.

2/ The Kew Lom Stage II adjacent to the Kew Lom Stage I included in the Project Area is supplied with water from the Kew Lom Dam. Therefore, the Kew Lom Dam operation study is made for the areas including the Kew Lom Stage II. The said irrigable areas are cited from the Preliminary Survey Report prepared by ECI. The details are discussed in ANNEX 3-1, 3.1.2. (1)

(b) Diversion water requirements

The diversion water requirements were estimated based on the irrigable areas and other factors mentioned below. The detailed computation is described in ANNEX 3-1, 3.1.2. (2)

Consumptive use

The consumptive use of the respective crops can be obtained by multiplying evapotranspiration by the crop factors in corresponding to growing stage of each crop.

(i) Evapotranspiration

Evaporation is usually computed by the results obtained from observation on pan evaporation, some equations in applying meteorological data. The current study adopted the Penman's method, one of the equations widely applied. As a result of computation, the annual evaporation was estimated at

1,288 mm with maximum value of 4.99 mm/day in April and minimum value of 2.50 mm/day in December.

(ii) Crop factors

The crop factors of the respective crops in their growing stages were taken from the RID's standard values. The related crop factors are shown in ANNEX 3-1, 3.1.2. (2).

The consumptive use of each crop was computed on the 10-day basis, and the maximum of paddy plan was estimated at 7.69 mm/day taking place in the middle of April in the dry season.

Percolation

Field percolation in the horizontal and vertical direction was estimated at 1.0 mm/day, which is included in losses.

Water requirements in land preparation and additionals

On top of the consumptive use of crops, it is necessary to consider the water requirements for land preparation for paddy cropping and those for preparatory works for upland crops. These additional water requirements were estimated crop-wisely at 200 mm for paddy, 50 mm for sugarcane and 40 mm for other upland crops.

Effective rainfall

Effective rainfall, which is taken by crop plants for their growing, was estimated as following criteria.

(i) Effective rainfall occupies 75 percent of the total rainfall.

(ii) The maximum effective rainfall differs from kinds of crops and was estimated as follows.

	Upper limit (mm/10 days)		
	Paddy	Sugarcane	Upland crops
	70	50	40

Irrigation efficiency

Some water loss will be caused in the irrigation water supply from dam to on-farm facilities. Under the circumstances, the irrigation efficiencies are considered, field efficiency, conveyance efficiency and operational efficiency. Based on this

concept, the integrated irrigation efficiency was estimated at 0.60 for paddy fields and 0.51 for upland fields respectively.

Crops	Field Efficiency	Conveyance Efficiency	Operational Efficiency	Total
Paddy	0.70	0.90	0.95	0.60
Upland	0.60	0.90	0.95	0.51

Diversion water requirements

In taking account the above various factors, the diversion water requirements for the Project were estimated on the basis of 10-day unit for water balance study during 26 years (1953 - 1978). According to the said estimates, the diversion requirements in 1967 when the 10-year probable effective rainfall took place in the Project Area, was taken up to be summarized as follows:

Diversion Water Requirement in 1967

	Paddy	Upland	Total
Irrigable Area (ha)			
Dry Season	4,408	8,749	13,157
Wet Season	15,118	2,387	17,505
Diversion Water Requirement (mm)			
Dry Season	1,386	557	1,943
Wet Season	835	189	1,024
Total	2,221	746	2,967

Note: The diversion water requirements of the upland crops were obtained as the weighted average of the diversion water requirements of the respective crops and their own irrigable areas. [ANNEX 3-1, 3.1.2 (2)] Details are attached in Table 5 and 6.

(c) Water balance

The Kew Lom Dam water balance computation is required to clarify the relationship between suppliable water amount from the Dam and the diversion water requirements estimated based on the proposed land use by zones. The computation should be made in taking into due consideration the water resources development plans comprising the existing Kew Lom Dam. As mentioned already in paragraph (1) the water resources development plans involve construction of the Project related dams such as the Kew Lom Dam and two dams of Kew Kor Mah and Mae Chang, however, the irrigation water supply to the Project Areas will totally depended upon the Kew

Lom Dam before completion of the other two dams. The Mae Chang Dam commanding the Mae Pung area as its beneficial area, will be started in its construction in the very near future.

The water balance computation, for the Kew Lom Dam, therefore, has been made on the two cases; (1) including and (2) excluding the Mae Pung Area.

The simulation study for clarifying the relationship between the diversion water requirement and the suppliable water amount from Dam was carried out in covering 26 years (1953 - 1978).

The water balance computation revealed the following matters.

- o In terms of annual water balance, the total runoff discharge at the Kew Lom Dam site would amount to about 663 MCM on an average, which is about three times as much as the annual diversion water requirements of 214 MCM, but drought will take place in some years because the seasonal distribution of runoff discharge does not always accord with that of the diversion water requirements.
- o The Kew Lom Dam operation by present operation rule will cause water shortage every year, particularly in the dry season, even if the Mae Pung area is excluded from the commanded area. Thereby, it is necessary to modify the present operation rule to secure the necessary amount of irrigation water.
- o The water balance computation according to the modified operation rule has found that the water shortage in maximum would take place in 1967 but not in almost of all other years.

The water shortage in 1967 would be estimated at 34 MCM (14.1 percent) against the water requirements of 241 MCM, including supply to the Mae Pung area, while 14 MCM (7.3 percent) against the water requirements of 193 MCM exluding supply to the Mae Pung area.

The water amount in shortage will be determined by the effective rainfall taking place in the Project Area and the inflow to the dam. The water shortage would take place in those 10-year probable drought years with less rainfall and inflow than the ordinary years. When the Kew Kor Mah Dam, however, is constructed upstream the Kew Lom Dam, the more effective water utilization by these dams will solve the problems of water shortage in these years. (The details are shown in Table 7 and Figure 3.

(d) Hydraulic design

i) Formula for discharge computation

The Manning's Formula was adopted to compute the discharge for determining canal capacity.

$$Q = A \cdot V, \qquad V = \frac{1}{n} \cdot R^{2/3} \cdot I^{1/2}$$

Where, Q. Discharge (m^3/sec)
A: Section area of the canal (m^2)
V: Velocity (m/sec)
n: Roughness coefficient of the canal
R: Hydraulic radius
I: Dynamic slope

The roughness coefficient of the concrete lining canals was adopted by 0.014 which has been employed by RID. And the allowable maximum velocity in principle was determined by 1.50 m/sec in a range that can secure stable flow.

ii) Typical section of the canals

Bottom width and freeboard of the canals

The bottom width and the freeboard of the main canals will be determined as follows depending upon the canal scale and inflow of the rainwater.

Main Canal

Discharge (m^3/s)	Bottom width (m)	Freeboard (m)
1.0 below	1.20	0.25
1.0 – 3.00	1.90	0.30
3.00 – 5.50	2.10	0.35
5.50 – 8.50	2.70	0.40

The sections of the lateral canals will be determined appropriately from the shown in ANNEX 3-1, 3.1.3 in taking into account the estimated discharges and canal slopes, and in this case, the freeboard would be determined by 0.15m. Figure 3-1-10 in ANNEX 3-1 shows the graph for determination of the section of the lateral canals.

Embankment slope

The embankment slopes for the main and the lateral canals are determined respectively as follows:

Main canal ..... 1 : 1.5 Lateral canal ..... 1 : 1.0

iii) Determination of design discharges for the canals

The design discharge of the canals was estimated by the following equation.

$$Q = q_p A_p + q_u A_u$$

Where, Q: Design discharge (m^3/s)

q_p: Unit water requirement at paddy field ($m^3/s/ha$)

A_p: Irrigable area paddy field (ha)

q_u: Unit water requirementat upland field ($m^3/s/ha$)

A_u: Irrigable area upland field (ha)

The unit water requirement at paddy field is, in general, determined by the water requirement on the last day of the land preparation on the concept that the land preparation works can be carried out for a certain constant acreage per day and the water requirement becomes largest on the last day of the works.

In due consideration of the long extended main canals in this Project, however, the method that the canal discharge should be constant during the land preparation period was adopted to alleviate the burden of the canal construction cost. And the unit water requirement in the wet season was taken as $q_p = 0.00163$ $m^3/s/ha$. The detailed discussion is made in ANNEX 3-1, 3.1.3.

The unit water requirement at upland field was determined by $q_u = 0.00035$ $m^3/s/ha$ based on the daily water requirement. The process of this estimation is described in ANNEX 3-1, 3.1.3.

4. 2. 4. Drainage Plan

(1) Estimate of drainage discharge

(a) Unit area drainage discharge inside Project Area

Drainage in the paddy fields

A natural drainage will be possible in the paddy fields of the Project Area where the fields are located in slope. In this case, the low-lying fields may be temporarily flooded by the drained water, but such a flooding will cause comparatively little damage to the crops, if remaining in an allowable extent.

Estimate of unit area drainage discharge

Generally, paddy plants will be affected by floods for their lasting period and flood depth, when flooded over 10 cm deep.

The designed unit area drainage discharge in this project was so determined that the flood would stand in a range from 10 cm to 20 cm in depth, lasting three days at the longest. (ANNEX 3-2, 3.2.1) The 10-year probable rainfall obtained from the data recorded at Lampang Station was adopted as design rainfall.

A series of computation has resulted in 4.19 ℓ/s/ha (0.67 ℓ/s/rai) of the unit area drain discharge for the Project. This value can be applied to the area below 320 ha, but for those areas over 320 ha the value would be modified by multiplying the reducing rate in corresponding to the acreage of the related catchment areas in taking into account the locality of rainfall intensity which is one of the characteristic features of the rainfall in the monsoon zone.

Unit area drainage discharge by catchment area

Catchment Area ha	Reducing Rate	Unit Area Drainage Discharge ℓ/s/ha
0 – 320	1.00	4.19
320 – 800	0.90	3.77
800 – 1,600	0.85	3.56
1,600 – 3,200	0.80	3.35
3,200 – 8,000	0.75	3.14
8,000 – 16,000	0.70	2.93

The drainage capacity designed for the respective drainage canals are shown in ANNEX 3-2, 3.2.4.

(b) Drainage outside Project Area

The drainage discharge for the canals which includes that from the catchment areas outside the Project Area was computed by adding the amount outside the Project Area, which was obtained by the Rotational method, to the amount inside the Project Area. The estimated drainage discharge outside the Project Area is tabulated as follows:

No. of Drainage Canal	Catchment Area outside the Project Area km²	Time of concentration hr	Peak Discharge m²/s
No.3	12.13	1.0	26.6
No.5	19.25	1.6	30.6
No.7	52.63	2.8	59.2
No.9	6.23	2.0	10.0

(2) Hydraulic design

All the drainage canals should be earth canals from the economical viewpoint.

(a) Basic concept on hydraulic design

The formulae adopted for computing discharge and velocity were the same ones used in the estimate of those for irrigation canals.

Roughness coefficient

For roughness coefficient of the drainage canals, which are the earth canals, the standard value of 0.035 was adopted for computation.

Allowable velocity

The maximum allowable velocity was adopted by 1.0 m/s in terms of soil conditions; however, the value 1.5 times as much as the above would be allowable for the design maximum discharge.

(b) Typical section of the drainage canals

Embankment slope

Embankment slope of all the main drainage canals should be designed at 1 : 1.5.

Freeboard

The freeboard should be designed at 0.30 m in principle, and the O & M roads with width 4.0 m should be provided along with all the main drainage canals.

(c) Determination of design discharge of the main drainage canals

The design discharge was estimated by the following equation.

$$Q = q \cdot A + Qo$$

Where, Q: Design discharge (m^3/s)
q: Unit area drainage discharge for inside area ($m^3/s/ha$)
A: Drainage area (ha)
Qo: Drainage discharge outside Project Area (m^3/sec)

The drainage discharge will be estimated for every drainage canal which provides the catchment area outside the Project Area. The design drainage discharges for the respective canals are shown in ANNEX 3-2.

4. 2. 5. Land Consolidation Plan

(1) Basic policy of the on-farm development plan

The land consolidation project has been rapidly promoted in Thailand since 1974 when the Land Consolidation Act was enacted. The land consolidation projects aim at establishing highly modernized farm management and increasing agricultural production through introduction of double cropping, more effective water utilization by rationalized management and upgrading of the farming techniques. All of these factors will be assured by improvement of farm lands as foundation of agriculture and the related on-farm facilities as well as consolidation of the main irrigation/drainage canals.

The Government of Thailand has tried to execute the land consolidation projects along with the staging development plans preparaed to meet the respective local requirements through assessing the results of many Ditches and Dykes Projects undertaken since 1962 together with thorough study on the project in terms of engineering, social and economical factors.

The Mae Wang - Kew Lom Project will be implemented along with the direction indicated in the Land Consolidation Act in taking either the intensive or the extensive method according to the local conditions prevailing in the Area so as to maximize the benefit to be generated from the investment to the land improvement project.

The intensive method aims at comprehensive farm land consolidation by land reparcelling and land levelling together with constructing and/or improving farm ditches/drains and farm roads. Therefore, the areas where this method is to be applied to should have potentiality to generate possibly large benefit from the development by full scale land consolidation. Whereas, the extensive method, in principle, will not involve the land reparcelling and levelling but implement construction and/or improvement of the farm ditches/drains, and provision of farm roads, if necessity requires. It is natural that the on-farm facilities in the extensive method should well function to assure the year-round irrigation and drainage so as for direct irrigation from their ditches to benefit the farmers more than 70 percent in the respective development areas.

On the other hand, the on-farm development should be implemented so as to meet the beneficial farmers' requirement under the close cooperation with their good understanding on the project. In this respect the 100 ha pilot land consolidation farm constructed in 1978 in the northern part of the Project Area has played a vitally important role to give a good example of the project in this kind and to deepen the understanding of the farmers concerned with MK-IADP. The importance of the pilot farm

can be proved by the results of survey on 100 selected farmers' consciousness for the land consolidation. The results of Pilot Farm evaluation, which was conducted by the survey team, are discussed in the ANNEX 4, 4.2.3.

The Project development plan has been worked out in taking into account the above matters as well as the following results of study on local conditions and Sample Area.

(2) Characteristic features of topography, soil and farm management in the Project Area

The topography of the Mae Wang and the Mae Pung areas is different from that of the Kew Lom Extension area. The former areas provide with farm lands on comparatively steep slopes along the existing main canals and with paddy fields on gentle slopes along the Wang River and in the south-western part of the Mae Pung area, while the Kew Lom Extension area provides with intricated topography and many steep slopes and the land reclamation is now under way in the area.

In general cases, the land levelling cost in the land consolidation works occupies about 35 - 45 percent of the total construction cost. The design of the works should be made in paying particular attention to the local topographic features to alleviate the burden in farmers' payment because the land levelling cost should be borne by farmers.

The slope classification in the paddy field areas in outlines as follows:

Slope Ranges	Acreage (ha)	Percentage (%)
below 1/1,000	1,540	11.5
1/1,000 – 1/500	2,764	20.6
1/500 – 1/200	2,692	20.1
1/200 – 1/100	3,569	26.6
over 1/100	2,835	21.2
Total	13,400	100.0

The soil conditions in the Project Area are favourable in general, and the considerablly thick top soil layers extend widely excepting for some parts in the Area. Under the circumstances, it is considered that there will be a little need to carry out the top soil treatment in land levelling.

The Sample Area surveys revealed that some gravel layers, fractured limestones, and pisolite layers were found scattered in the Sample Areas. Judging from the nature of the land consolidation works, temporary yield reduction would be unavoidable unless much more application of organic matters and fertilizers than ordinary design is carried out for two or three years after land consolidation implemented.

The dry season cropping ratio in the Area has been increased by as high as 30 percent with paddy and upland crops as well. Since the farming techniques in the Project Area are considered rather high, more intensive farming will be introduced in the Area after the Project completed.

(3) Design Criteria

Standard plot shape

Most of the farmers (more than 95 percent) in the Area are owner farmers, but the land holdings per farmer are about 1.30 ha, which is below the national average of land holdings. In due consideration therefore, on possible reduction of public facilities' land rate, topographical conditions and local farm management status, the standard of plot size is determined as 100 m - 150 m for length of run and 30 m - 60 m for width and farm ditches and drains are constructed at the same interval.

Irrigation plan

The capacity of proposed farm ditches should be determined in considering the data on water requirements in both the dry and the wet seasons, kinds of crops to be grown, number of land preparation days, etc. And the land preparation was planned to take 20 days and the respective unit water requirements of paddy and upland crops are 2.5 ℓ/s/ha and 0.6 ℓ/s/ha, so that the rotational irrigation can be carried out in the drought years.

Drainage plan

The proposed farm drains should have a capacity to drain the farm lands only under the concept that no inflow water takes place to the inside area, excepting for some limited areas. Under the local drainage conditions, most of the Project Area would be free from a long-lasting inundation by mere improvement of drainage facilities. The drainage discharge was estimated previously at 42 ℓ/s/ha.

Road plan

The public road networks in the Project Area are well arranged with rather high density, whereas the farm roads and the community roads linking with villages

are very thinly provided. The planned farm road width was designed by 4.00 m, in taking into account the results of farmers' census, a little anticipation for farm mechanization in terms of land tenure, farming techniques and social environments.

(4) Approach to development

The five Sample Areas with different areal conditions have been selected in order to study the approach to the on-farm development in the Project Area. The general descriptions of these Sample Areas are shown below and their locations are illustrated in ANNEX 1-2, Figure 1-2-1.

Sample Name	Average Slopes	Acreage ha	Land Use (%) Paddy field	Upland field	Forest	Existing Public Land Ratio (%)
1	1/20 – 1/200	220	76	12	12	2.8
2	1/10 – 1/180	210	51	12	37	1.8
3	1/100 – 1/200	140	100	0	0	2.2
4	1/800 – 1/1,000	140	100	0	0	1.8*
5	1/50 – 1/250	170	100	0	0	3.0
Details on Sample Area No.5	1/50 – 1/150	60	100	0	0	3.0
	1/100 – 1/150	48	100	0	0	3.0
	1/150 – 1/250	62	100	0	0	3.0

* The public land rate of 1.8 percent in No.4 excludes 2.4 percent of land rate for the main drainage canal space.

The earth moving volume in the land levelling for the land consolidation project in Thailand averages by 400 - 450 m^3 per ha (70 m^3 per rai).

The Sample Area No. 1, 2, 3 and a part of No. 5, the earth moving volumes in which appear to exceed the maximum volume quoted above, would be designed by Extensive Method, and the Sample Area No.4 and the remaining part of No. 5 by Intensive Method. The design drawings concerned are attached to this report as Figure 4-1 to 4-9 in ANNEX 4. The public lands to be required would occupy about five percent in the former case and 6.5 percent in the latter case respectively.

The density of proposed on-farm facilities and earth moving volumes estimated for the detailed design of each sample Area are summarized as follows:

Sample Name	Method	Farm Road (m/ha)	Farm Ditch (m/ha)	Farm Drain (m/ha)	Earth Moving Volume (m^3/ha)
No.1	Ext. M	18.9 (2.2)	52.5 (52.5)	18.8 (1.6)	–
No.2	Ext. M	38.8 (0)	59.2 (59.2)	22.3 (1.3)	–
No.3	Ext. M	27.9 (7.3)	72.4 (72.4)	26.7 (12.2)	–
No.5	Ext. M	21.5 (9.1)	67.7 (67.7)	31.0 (0)	–
Average	Ext. M	26.8	63.0	24.7	
No.4	Int. M	57.8	57.9	37.7	393
No.5	Int. M	61.5	76.9	45.3	388
Average		59.6	67.4	41.5	390

Note: Figures in parenthesis for Extensive Method indicate the proposed length to be constructed or improved.

According to the above data, the construction cost was estimated using the unit price as of October, 1979 (fiscal 1980), and the results and development classifications are shown as follows. In the said table, on-farm development acreages of the paddy fields and upland fields involved in the Lampang City Planning Project were excluded.

Method	Objective Area ha	Applied Sample No.	Average Slope	Cost on the force account basis ฿/ha(฿/rai)	Cost on the Contract basis ฿/ha(฿/rai)
Intensive					
I1	2,344	5	1/200 - 1/500	17,711 (2,833)	26,447 (4,231)
I2	3,864	4	below 1/500	14,057 (2,249)	22,434 (3,589)
Average	6,208			15,884 (2,541)	24,440 (3,910)
Extensive					
E1	1,312	3	Over 1/100	11,500 (1,840)	15,083 (2,413)
E2	2,451	2	Kew Lom	6,893 (1,102)	10,126 (1,620)
E3	2,474	5	1/100 - 1/200	8,550 (1,368)	11,515 (1,842)
Average	6,237			8,981 (1,436)	12,241 (1,958)
Total	12,445				

As the on-farm development method in this Project the intensive and the extensive methods would be applied by 50 percent each for the Area. The method-wise acreages of on-farm development are shown in TAble 8 and Figure 4.

4. 3. Agricultural Development

4. 3. 1. Agricultural Production

At present, the irrigation water supply has been inadequately carried out in the Project Area due to insufficient provision of necessary facilities and improper water management. The Project, however, will enable the entire proposed area to be irrigated adequately, when completed. The present cropping rate of the dry season crops has remained low due to insufficient water supply as well as yet-unestablished dry season farming techniques.

The Project will allow the agricultural production of the Area to be increased sharply with the cropping intensity raised from present 127 percent to around 179 percent. The anticipated stable irrigation water supply will raise the efficiency of investment in forms of agri-chemicals and fertilizers to result in bringing the synergy effect to the agricultural production.

In most cases, the highest yield in the agricultural development projects does not always produce the highest income. Particularly in Thailand, the highest income can be mostly obtained in case that the amount of the input materials is comparatively small, because of high cost of input materials, low market prices of the products and the problems of the distribution system. The results of the studies made in this connection are detailed in Table 5-2, ANNEX 5.

The target yields of the respective crops planned to be grown in this Project were estimated as follows on the basis of the results of experimental cropping in the farmers' fields and results of yield survey carried out in this Area, and the data and records prepared by the FAO and by MOAC of the country together with consideration on the specific features of the local farming conditions.

The target year to attain the target yields was determined by five years later from the Project completion year. The detailed information on improved techniques to backup the production increase is discussed in ANNEX 5. The major crops in the Project Area are paddy, peanut, tobacco, garlic, soybean, etc. Among them, the paddy production is anticipated to be increased by 102 percent to raise present 35,300 tons to 71,200 tons, and peanut, tobacco and garlic are expected to be increased in production by 187 percent, 60 percent, and 256 percent respectively.

4. 3 2. Farm Inputs and Labors

(1) Farming practices

At present, 80 percent of the preparation works in paddy cropping, such as plowing, harrowing, puddling, etc., have been carried out in depending upon the labour resources of buffalos, and the remaining 20 percent depends upon power tillers. In growing the other crops than paddy, nearly 100 percent of the preparatory works have been carried out by buffalos or cattle.

According to development of the Project, the diffusion rate of mechanized farming in the Area will be increased to some 30 percent of the total preparatory works for any crops. The farm mechanization should be encouraged in due consideration of collective performances in purchasing and operating machines so as to alleviate the farmers' economic burden and to raise their working efficiency.

(2) Seeds and seedlings

The estimated optimum amount of seeds and seedling for various croppings in the Area are illustrated in Table 9. The extension agents will have to render elaborate extension services to farmers in indicating the practically optimum amount of these inputs.

(3) Fertilizers

Optimum amount of fertilizers as well as seeds and seedlings are indispensably applied to accomplish the targets in the respective yield. The crop-wise designed fertilizing amounts are determined on the basis of the results of experiments performed in Lam Pang by FAO. The details are shown in Table 9. Also, fertilization by the designed amount should be carried out under the guidance of extension agents.

(4) Agri-chemicals

According to the farm survey conducted in the Project Area, agri-chemicals have been applied mainly to vegetables, tobacco, chilli and no application or negligibly little application has been made to other crops. Particularly, almost of all farmers in the Area have not used the chemicals for the wet season paddy cropping. That will be not only because the benefit generated from fertilization exceeds that generated from the chemical application under the situation. The investment to chemicals application will not increase so much as expected in the fertilizer application.

(5) Labours

The estimated farm labour demands in "with project" condition is about 2,895,000 man/days per annum, which is about 1.9 times as much as that at present.

The labour demand is expected to reach its peak in June and November to December, which fall under the harvest season of the dry season paddy and the wet season paddy cropping, respectively. During the above labour peak, 27,000 - 32,000 man-days labour will be required for a day, but it is anticipated to cope with the situation by full employment of the family and the hired labour together with much more machine power than at present.

4. 3. 3. Agricultural Extension

As stated previously, agricultural extension services have been greatly strengthened in the recent years. The Project Area must practice highly intensive agriculture in future. Otherwise the farmers of the area will lag far behind economically in comparison to those of the other areas where holdings are much bigger. Intensive agriculture must be supported by higher technology. As sources of technology, there are various research institutions as stated earlier. The extension service must carry out its work in close cooperation with these research organs. However, what is really needed in the Project Area in this respect is "the results of experiments conducted on fertile soils under irrigable conditions". There is a few experiment station in Thailand which can really answer such requirements. Accordingly the extension service must carry out many experiments which will act as demonstration. As stated in the Section on soil, soils of the area are generally fertile but variable in fertility as a characteristic of mountainous area. In this sense also, many experiments are needed. Number of Mubans in the area are seventy-eight. If possible one experiment per one Muban is desired. Results of experiments must be such that farmers can observe them wherever they live. This is the first requirement.

The second requirement is that the experiment should be as simple as possible, so that it can be understood by anyone. To say the extreme, the experiment may be of only two treatments, that is, the traditional practice versus an overall improvement involving new varieties and fertilizer application and so on. Cost of overall improvement must be shown on the signboard erected beside the plot At the termination of the experiment, balance sheet must be shown to the farmers.

The third requirement is that the plot size should be at least 50 m^2. Farmers do not believe in the results obtained on small plots. Difficulty of large plot size is that experimental land should be large and flat to be uniform in fertility. If the land is large enough to hold more than two plots, partially improved treatments such as new variety without fertilizer, local variety with fertilizer can be included.

Cost of these experiment is small. Farmers who offer their land for experiment are usually satisfied by obtaining increased yield by improvement. Cost of fertilizer are practically the only expenditure.

Besides demonstrative experiments above-mentioned, extension agents should carry out fertilizer experiments of the following design. This is to know whether phosphate and potash are really needed or not. Necessity of nitrogen for various crops other than legumes is beyond doubt. Results of fertilizer experiments indicate phosphate and potash have not to be applied. But some of the soil analysis show that phosphate and potash in the soil are not sufficient. After all, the first stage of improvement in agricultural practice is simply a matter of introduction of good varieties and application of suitable formula of fertilizers. In this sense it is important. This is especially so in Thailand where prices of agricultural products are low and prices of fertilizers, though not especially expensive by internal standard, are relatively high.

Unit: kg/ha

Treatment	N	P_2O_5	K_2O
1 No fertilizer	0	0	0
2. No nitrogen	0	50	50
3. No phosphorus	50	0	50
4. No potash	50	50	0
5. Complete fertilizer	50	50	50

Under the present conditions of Thailand, unresponsive elements should not be applied. According to the basic concept of the agricultural extension works, a project team, which should be formed on the ground of the Extension office in Changwat Lampang, shall play a role to make the Project functional as real Pilot area in the North Thailand and to give education and guidance to the farmers concerned for accomplishing the target In order to make the activities smoothen and realistic, some 30 Farmers' are to be selected from the farmers by one foreman for covering about 500 ha, and they shall assist the extension agents in rendering services and take initiative in every activity to lead the farmers concerned. Furthermore, some study groups of farmers should be formed with 20 - 30 farmers each, as a fundamental organization, and the leaders of such groups and the Farmers' Foremen should have close contact to give elaborate services to the farmers. The Government should take a measure to be required for subsidizing for these activities in the initial stage of the services.

4. 3. 4. Upbringing and Strengthening of Agricultural Cooperatives

(1) Organization of Agricultural Cooperatives

There are three agricultural cooperatives in the project related three Amphoe on which the previous section 3.3.7. describes. About 2,080 farmers in the Project Area have presumably entered the membership of either of these three cooperatives, but the above figures occupy only about 17 percent of 12,400 farmers, the estimated total number of the farmers in the Project Area.

At present, farmers crediting service is a main work of the cooperatives, which the member farmers cited above have been enjoying. It is necessary, however, to bring up and strengthen the present cooperative organizations to serve the farmers concerned through a wide range of activities such as sales of input materials/equipment for effective farming and procurement of farm products for marketing, etc. It is ideal that the existing three cooperatives is unified to one integrated cooperative to render general services for the farmers of full membership in the Project Area.

Practically, however, it will be recommendable to strengthen the existing three cooperatives respectively in considering the fact that there are the Mae Chaung Project and the Kew Lom No 3 Extension Project existing around the Project Area. For attaining this purpose, powerful guidance and assistance by Department of Agricultural Cooperative Promotion are indispensably required.

(2) Cooperatives' activities

The service volume by cooperatives will be increased as the related membership increases in number. Such expansion of services will require an increasing provision of staff, equipment and materials so as to treat the increasing services. The cooperatives activities currently required are to upgrade and expand the major services as follows.

- o Agricultural crediting services
- o Procurement and sales of farm inputs (seeds, fertilizers, farming machinery and equipment, etc.)
- o Procurement and sales of farm products and improvement of marketing services
- o Utilization of agricultural machine centre and encouragement farm mechanization
- o Establishment of farmers' deposit system and its strengthening
- o Collection of water charges and other allotment to farmers

A part of the above services have been rendered by some cooperatives, but not in systematic operation. The agricultural crediting is considered as one of the important factors to increase the farm production in the course of Project implementation or immediately after completion of the Project

The present credit is mainly dependent upon the money borrowed from the BAAC, and much more credit will be available when the present organization is strengthened, reliability of the cooperatives is raised by increase in number of member farmers, and the present rather complicated procedures are simplified.

(3) Farmers education

Thorough extension services and upbringing of the cooperatives as well as investing to the land improvement works will be mainstays of the agricultural administration for developing more intensive agriculture in the Project Area in the "with Project" conditions. The steady education and guidance of the farmers are highly desirable to accomplish the above targets in accordance with the progress of the local agriculture. The education or training as mentioned above is expected to be given to farmers in schedule covering the general agricultural matters as well as exercising of water management and farming practices.

(4) Operation of agricultural cooperatives

The operation and management of the cooperatives should be conducted by the staff of cooperatives themselves assigned to the respective positions along with the direction by committees concerned. However, experiencing the generalization and systematization all the cooperative indispensably require the financial aid and administrative guidance by authorities concerned on their way to the full-scale development. Therefore, it is anticipated that the Government can extend its possitive assistance and guidance to this Project with the fundamental policies prepared.

4. 4. Physical Plan

4. 4. 1. Irrigation Facilities

(1) Names and classification of the irrigation canals

The irrigation canals to be provided in the Project are classified into the following two in terms of their layout.

a) Main canals

In principle, change of the main canal alignment is not taken into consideration because improvement works will be the major project works for the main canals

The main canals in the Project are the following seven routes, which would be all concrete lined. For further information, necessity of concrete lining for the main canals is discussed in ANNEX 3-1, 3. 1. 3.

i) Mae Wang Left Main Canal

This canal extends 38.4 km to convey the water diverted at the Sop Ang Diversion Dam from the Wang River, and the canal slope would remain in what it is now in considering the use of existing syphons and bridges.

ii) Mae Wang Right Main Canal

This canal extend 353 km to convey the water diverted from the Kew Lom Main Canal by link canal to the Tui River, and the canal slope for a greater part would remain in what it is now, excepting for the terminal portion which will have slightly gentler slope than at present so as to raise the water level slightly higher.

iii) Kew Lom Main Canal

The Kew Lom Dam directly divert the water to this canal, which has been constructed all in concrete lining in the Project Area, and no improvement works are planned for this canal.

iv) Mae Pung Main Canal

This canal is branched off from the Mae Wang Left Main Canal at its 33.9 km point, extending 5.6 km in total, and the canal slope would keep the same rate as that at present.

v) Mae Pung Right Canal

This canal will convey the water diverted from the planned Mae Chang Dam to the Project Area, and the canal slope would keep the same rate as that at present.

vi) Mae Pung Left Canal

The improvement works would be implemented for this canal to the same extent as the above Mae Pung Right Canal.

vii) Link Canal

This canal links the Mae Chang Right Main canal with the Mae Pung canal to divert the water of about 4.94 m^3/sec, extending about 2.0 km.

b) Lateral Canals

The lateral canals, branching off from the main canals with diversion structures, divert the water to the on-farm, irrigation facilities. The laterals are so designed that one lateral can cover about 80 ha (500 rai) paddy fields. All laterals are concrete-lined and no improvement works are implemented for these laterals as a rule, excepting for some parts which need to be hightened for raising the water level.

Besides the above canal improvement works, O & M roads would be provided along the main and the lateral canals with width of 6.0 m (effective width: 5.0 m) for the main and 4.0 m (efficient: 3.0 m) for the lateral respectively.

(2) Appurtenant structures

The major appurtenant structures to the canal works are as follows:

i) Check gates

Check gates will be constructed at the main or lateral canals to dam up for securing a proper water level, and the sites of the structures will be determined according to canal slope, and location of diversion works.

ii) Division works

The division works will be provided at the diversion points from the main to the laterals and from the laterals to the on-farm irrigation facilities. The division works should have such a structure to check the discharge for facilitating the water management in the future Project works. Generally, the constant head orifice will be provided, but the Parshall flume for the canals with a large amount of water discharged.

iii) Spillways

The spillways should be provided at every points that the canal capacity changes. The side-ditch type structures will be adopted for the purpose and the overflow width will be determined according to the canal capacity.

iv) Wasteways

The wasteways should be constructed in every main canal at the site close to the syphons for easy connection with the rivers.

v) Drop works

The drop works should be provided in the canals at proper sites for securing the safety of the canals in considering the topo-slope conditions, flow velocity, etc.

vi) Inlets

The inlets will be installed at proper sites along the main canals on the both banks so as to treat the excess water from the outside of the Project Area.

vii) Bridges

All of the existing wood-made bridges will be rebuilt with concrete.

viii) Culverts

As a general rule, the pipe culverts will be installed when the small capacity drains cross the irrigation canals or the small capacity irrigation canals cross the roads.

4. 4. 2. Drainage Facilities

(1) Main drainage canals

There will be 11 main drainage canals to be provided, which will function to drain only the areas involved in the Project, and those which command the catchment areas outside the Project or the small catchment areas inside the Project Area as compared with the catchment area outside the Project Area are excluded from the plan. (ANNEX 3-2, 3.2.2. and Figure 3-1-11)

(2) Sluice gate

The comparative study on the estimated Wang River's water level with the water level at the outlet of the main drainage canals for the 10-year probable flood in the Wang River found that the inside water level (drainage water level) would be higher than the outside water level (river water level) in the upperstream of the Lampang City, while the adverse phenomenon would take place in the downstream thereof. In due consideration of the above study, the sluice gates will be provided in the downstream. (ANNEX 3-2, 3.2.3.)

Therefore, further surveying and study are required for the Wang River and the respective drainage canals to make a definite plan of the sluice gate installations.

(3) Appurtenant structures

The proposed appurtenant structures of the drainage canals include bridges, roads, culverts to cross the irrigation canals, drops, etc. For the crossing structure, the bridges would be provided for the drainage canals with over 4.0 m^3/s design discharges and the three-unit 1.0 m dia (maximum) pipe culverts for those with below the above design discharges. The drop works would be provided with the standard drop of 1.0 m when the discharges exceed the permissible maximum velocity.

4. 4. 3. Land Consolidation and Related On-farm Facilities

As mentioned in paragraph 4.2.5, the on-farm development of the Project will adopt either of the intensive method with complete land consolidation works or the extensive method only with some improvement works for ditch/drain, roads, etc. The acreages which the respective methods will be applied would occupy 50 percent each for the proposed on-farm development areas.

The proposed appurtenant structures of the on-farm development include water distribution system to supply the water diverted from the main/lateral canals, and division works, division boxes, crossing culvert, drop works, etc.

The layout and design for these facilities should be carefully studied according to the adequate topo-maps and cadastral maps and in taking the results of consultation with the beneficiary farmers into due consideration. In particular, a thorough consultation with land owners is essentially required prior to implementation of the construction works so as to perform the smooth execution of the Project.

4. 4. 4. Coordination with the Related Projects

The execution of the Project will deeply concern with the following three projects directly or indirectly. Thereby, the Project should be executed under close coordination with these three projects in coping with their progress during and after its construction works as well.

(1) Mae Chang Dam Project

The project aims at developing the water resources to irrigate stablly about 16,000 ha, including 3,186 ha of the Mae Pung area involved in this Project. According to the RID's schedule, the project plan will be formulated in corresponding to the project implementation of this MK-IADP.

For quick yielding in the Mae Pung area, the early implementation of this MK-IADP is essential to realize the irrigation plan, land consolidation plan, etc. which have close relations with the Mae Chang Dam project. Therefore, the closest coordination should be made between the two projects so as to assure their execution smoothened.

(2) Lampang City Planning Project

The City planning project has been under way in the area of 2,900 ha in around Lampang city located in the Project Area. This programme aims at carrying out the urban area development, which will be implemented at a slow but steady pace compared with the pace of this MK-IADP.

The MK-IADP has planned to exclude the area of 1,337 ha farm lands covered by this city plan from the investment objective for the land improvement works. However, the implementation of the above 1,337 ha by the MK-IADP will have to be ready to cope with situation which may change in future during the construction period and the closest coordination between the two executing bodies of the projects should be made for efficient and smooth implementation.

(3) Settlement (NIKOM) Project

The project has been executed under the administration of the Ministry of Interior in the Kew Lom Extension area. This project also includes so many a MK-IADP related work items such as roads, agri-supporting services that the closest coordination and cooperation is required to smoothen the both Project works.

4. 5. Estimated Work Volume and Project Cost

4. 5. 1. Estimated Work Volume

(1) Construction and/or improvement of major facilities

The main system improvement works are tabulated as follows:

Facilities	Quantity (km)	Work Items	
A. Irrigation canal			
Mae Wang Left Main	38.40	Concrete lining/ Appurtenant structures	33 sites
Mae Wang Right Main	35.29	"	43 sites
Mae Pung Main	5.61	"	14 sites
Mae Pung Left Main	6.52	"	27 sites
Mae Pung Right	12.30	"	25 sites
Link canal	12.00	"	one site
Sub-total	100.12		
Lateral canal	79.65	All conctete lining/ Appurtenant structures	550 sites
Sub-total	79.65		
B. Drainage canal		Cross section adjustment/ Appurtenant structures	65 sites
Main drainage canal	61.00		
Sub-total	61.00		
Total	240.77		

C. Land Acquisition

Irrigation canal	116.4 (ha)
Drainage canal	126.6
Total	243.0

(2) Land consolidation works

Development Method	Acreage	Major Work Items
Intensive Method	6,208 ha	Land Levelling & construction/ improvement of Farm ditch/drain and roads.
Extensive Method	6,237 ha	Construction and improvement of farm ditch/drain and roads
Upland and Field & orchards	1,982 ha	Including in the beneficial areas without implementing construction works.
City planning area	973 ha	- ditto -
Total	15,400 ha	

4. 5. 2. Project Cost

The Project cost can be broken down into construction cost, operation and maintenances cost, equipment procurement cost, consultants fee, contingency, administration cost and price escalation allowance as shown below.

Item	Foreign Currency	Local Currency	Total	Percentage to F.C.
	(Million Baht)			(%)
Construction cost	128.50	255.46	383.96	33.5
Equipment Procurement cost	100.50	5.46	105.96	94.8
Consultants Fee and Training cost	23.28	4.77	28.05	83.0
Contingency and Administration cost	15.10	73.53	88.63	17.0
Sub-total	267.38	339.22	606.60	44.1
Price Escalation Allowance	40.10	50.90	91.00	
Sub-total	40.10	50.90	91.00	44.1
Total	307.48	390.12	697.60	44.1

The construction cost was estimated based on the design criteria and the layout for the major facilities and on the detailed design of the Sample Areas for the on-farm development. The contingency was obtained as 10 percent of the total of construction cost, consultants fee, training cost and administrative cost. The price escalation allowance was estimated by 15 percent. And hence, the project cost amounted to about

600 million Baht. The total Project cost including the price escalation allowance amounted to about 700 million Baht. The cost per hectare for the about two amounts was computed at ฿ 39,400 (฿ 6,300 per rai) and ฿ 45,300 (฿ 7,250 per rai) respectively. The foreign currency occupies 44.1 percent of the total construction cost. The breakdown in details is illustrated in Table 10, 11, 12 and 13 respectively.

Table 4. Present and Proposed Cropping Patterns (Project Area as a Whole)

Unit: ha

Crops	Present			Proposed		
	Wet Season	Dry Season	Total	Wet Season	Dry Season	Total
1. Paddy	12,300	472	12,772	13,400	4,740	18,140
2. Peanut	401	1,275	1,676	330	3,100	3,430
3. Tobacco	95	704	799	340	850	1,190
4. Soybean	144	462	606	255	800	1,055
5. Chilli	174	35	209	230	560	790
6. Garlic	0	531	531	0	1,500	1,500
7. Sugarcane	200	200	200	200	200	200
8. Pineapple	100	100	100	100	100	100
9. Vegetable	346	371	717	295	600	895
10. Orchard	250	250	250	250	250	250
	14,010	4,400	17,860	15,400	12,700	27,550

Cropping Intensity: Present ----- $\frac{17,860 \text{ ha}}{14,010} \times 100 \fallingdotseq 127\%$, Proposed ----- $\frac{27,550}{15,400} \times 100 \fallingdotseq 179\%$

Table 5. Diversion Water Requirement for Paddy Rice in 1967

		Effective Rainfall	H.Y.V. Net Water Requirement		H.Y.V. Diversion Water Requirement			L.V. Net Water Requirement		L.V. Diversion Water Requirement		
		(mm/day)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)	(mm/day)	(ℓ/s/ha)	(mm/day)	(mm)	(ℓ/s/ha)
Jan.	1	0.00										
	2	0.01	0.62	0.072	1.03	10.3	0.120					
	3	0.00	6.95	0.809	11.58	127.4	1.340					
Feb.	1	0.00	8.53	0.987	14.22	142.2	1.645					
	2	0.00	9.93	1.149	16.55	165.5	1.915					
	3	0.00	4.63	0.535	7.72	61.8	0.892					
Mar.	1	0.00	5.86	0.678	9.77	97.7	1.130					
	2	0.03	6.19	0.716	10.32	103.2	1.193					
	3	0.00	6.48	0.750	10.80	118.8	1.250					
Apr.	1	0.00	7.55	0.874	12.58	125.8	1.457					
	2	1.87	5.82	0.674	9.70	97.0	1.123					
	3	1.75	5.90	0.683	9.83	98.3	1.138					
May	1	3.97	3.00	0.347	5.00	50.0	0.578					
	2	2.12	4.68	0.542	7.80	78.0	0.903					
	3	2.30	4.20	0.486	7.00	77.0	0.810					
Jun.	1	5.56	0.00	0.000	0.00	0.0	0.000					
	2	1.37	1.49	0.172	2.48	24.8	0.287					
	3	0.86	0.46	0.053	0.77	7.7	0.088					
Jul.	1	1.60						6.17	0.714	10.28	102.8	1.190
	2	4.86						4.73	0.547	7.88	78.8	0.912
	3	1.26						8.35	0.967	13.92	153.1	1.612
Aug.	1	1.43						3.35	0.388	5.58	55.8	0.647
	2	0.71						3.62	0.419	6.03	60.3	0.698
	3	6.36						0.00	0.000	0.00	0.0	0.000
Sep.	1	1.66						3.37	0.390	5.62	56.2	0.650
	2	3.43						1.85	0.214	3.08	30.8	0.357
	3	7.00						0.00	0.000	0.00	0.0	0.000
Oct.	1	1.12						4.19	0.485	6.98	69.8	0.808
	2	1.96						3.22	0.373	5.37	53.7	0.622
	3	0.55						4.48	0.519	7.47	82.2	0.865
Nov.	1	1.21						3.07	0.355	5.12	51.2	0.592
	2	1.75						2.40	0.278	4.00	40.0	0.463
	3	0.58						0.00	0.000	0.00	0.0	0.000
Dec.	1	0.10										
	2	0.00										
	3	0.00										

Note: (1) Effective Rainfall (See Table 3-1-7)

(2) Diversion Water Requirement: Net Water Requirement/Irrigation Efficiency (0.60).

Table 6. Diversion Water Requirement for Upland Crops in 1967

		Effective Rainfall	Peanuts					Tobacco					Soybean and Chilli				
			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement		
		(mm/day)	(mm/day)	(l/s/ha)	(mm/day)	(mm)	(l/s/ha)	(mm/day)	(l/s/ha)	(mm/day)	(mm)	(l/s/ha)	(mm/day)	(l/s/ha)	(mm/day)	(mm)	(l/s/ha)
Jan.	1	0.00						2.08	0.241	4.08	10.8	0.473					
	2	0.01						1.42	0.164	2.78	27.8	0.322					
	3	0.00						1.67	0.193	3.27	36.0	0.378					
Feb.	1	0.00	1.59	0.184	3.12	31.2	0.361	2.61	0.302	5.12	51.2	0.592	1.59	0.184	3.12	31.2	0.361
	2	0.00	2.06	0.238	4.04	40.4	0.467	2.92	0.338	5.73	57.3	0.663	2.06	0.238	4.04	40.4	0.467
	3	0.00	2.64	0.305	5.18	41.4	0.598	3.10	0.359	6.08	48.6	0.704	2.53	0.422	4.96	39.7	1.808
Mar.	1	0.00	2.41	0.279	4.73	47.3	0.547	3.47	0.459	7.78	77.8	0.900	2.27	0.263	4.45	44.5	0.516
	2	0.03	2.87	0.332	5.63	56.3	0.651	3.82	0.442	7.49	74.9	0.867	2.55	0.295	5.00	50.0	0.578
	3	0.00	3.62	0.419	7.10	78.1	0 822	3.15	0.365	6.18	68.0	0.716	3.21	0.371	6.29	69.2	0 727
Apr.	1	0.00	4.56	0.528	8.94	89.4	1.035	2.45	0.284	4.80	48.0	0.557	4.34	0.502	8.51	85.1	0.984
	2	1.87	1.94	0.225	3.80	38.0	0.441	0.00	0.000	0.00	0.0	0.000	2.86	0.331	5 61	56 1	0 649
	3	1.75	0.43	0.050	0.84	8.4	0.098	0.00	0.000	0.00	0.0	0.000	2.82	0.326	5.53	55.3	0.639
May	1	3.97	0.00	0.000	0.00	0.0	0.000						0.00	0.000	0.00	0.0	0.000
	2	2.12											0.00	0.000	0.00	0.0	0.000
	3	2.30											0.00	0.000	0.00	0.0	0.000
Jun.	1	4.00															
	2	1.37															
	3	0.86															
Jul.	1	1.60	0.75	0.087	1.47	14.7	0.171	0.59	0.068	1.57	15.7	0.133	0.75	0.087	1.47	14.7	0.171
	2	4.00	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0 00	0.0	0.000
	3	1.26	1.09	0.126	2.14	23.5	0.247	0.73	0.084	1.43	15.7	0.165	0.99	0.115	1.94	21.3	0.225
Aug.	1	1.43	0.40	0.046	0.78	7.8	0.090	0.67	0.078	1.31	13.1	0.153	0.28	0.032	1.82	18 2	0.063
	2	0.71	1.50	0.174	2.94	29.4	0.341	0.98	0.113	1.92	19.2	0.222	1.23	0.142	2.41	24.1	0.278
	3	3.64	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
Sep.	1	1.66	1.36	0.157	2.67	26.7	0.308	0.85	0.098	1.67	16.7	0.192	1.24	0.144	2.43	24.3	0.282
	2	3.43	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	3	4.00	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
Oct.	1	1.12	0.00	0.000	0.00	0.0	0.000	1.92	0.222	3.77	37.7	0.435	1.26	0.148	2.51	25.1	0.290
	2	1.96						0.96	0.111	1.88	18.8	0.218	0.00	0.000	0.00	0.0	0.000
	3	0.55						1.83	0.212	3.59	39.5	0.416	0.03	0.000	0.06	0.7	0.000
Nov.	1	1.21						0.15	0.017	0.29	2.9	0.033	0.00	0.000	0.00	0.0	0.000
	2	1.75						0.00	0.000	0.00	0.0	0.000					
	3	0.58						0.00	0.000	0.00	0.0	0.000					
Dec.	1	0.10						0.98	0.113	1.92	19.2	0.222					
	2	0.00						0.35	0.041	0.69	6.9	0.080					
	3	0.00						0.63	0.073	1.24	13.6	0.143					

		Effective Rainfall	Garlic					Vegetable or Fruits					Sugarcane				
			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement			Net Water Requirement		Diversion Water Requirement		
		(mm/day)	(mm/day)	(l/s/ha)	(mm/day)	(mm)	(l/s/ha)	(mm/day)	(l/s/ha)	(mm/day)	(mm)	(l/s/ha)	(mm/day)	(l/s/ha)	(mm/day)	(mm)	(l/s/ha)
Jan.	1	0.00	2.26	0.262	4.43	44.3	0.514	1.61	0.186	3.16	31.6	0 365	1.92	0.222	3 76	37.6	0.435
	2	0.01	1.43	0.166	2 80	28.0	0.325	1.87	0.216	3.67	36.7	0.424	2.19	0.253	4 29	42.9	0.496
	3	0.00	1.86	0.208	3.53	38.8	0.402	1.89	0.219	3.71	40.8	0.429	2.51	0.291	4.92	54.1	0.571
Feb	1	0.00	2.82	0.326	5.53	55.3	0.639	2.39	0.277	4.69	46.9	0.543	1.91	0.221	3 75	37.5	0.433
	2	0.00	3.12	0.361	6.12	61.2	0.708	2.39	0.277	4.69	46.9	0.543	3.08	0.356	6.04	60.4	0 698
	3	0.00	3.19	0.369	6.25	50.0	0.724	2.39	0.277	4.69	37.5	0.543	3.28	0.380	6.43	51.4	0.745
Mar.	1	0.00	3.23	0.381	6.45	64.5	0.747	3.00	0.347	5.88	58.8	0.680	4.35	0.503	8.53	85.3	0.986
	2	0.03	1.92	0.222	3.76	37.6	0.435	2.97	0.344	5.82	58.2	0.675	4.53	0.524	8.88	88.8	1.029
	3	0.00	0.75	0.087	1.47	16.2	0.171	3.00	0.347	5.88	64.7	0.680	4.78	0.553	9.37	103.1	1.084
Apr.	1	0.00	0.01	0.000	0.02	0.2	0.000	3.49	0.404	6.84	68.4	0.792	5.77	0.668	11.31	113.1	1.310
	2	1.87						1.63	0.189	3.20	32.0	0.371	4.01	0.464	7.86	78.6	0.910
	3	1.75						1.75	0.203	3.43	34.3	0.399	4.24	0.491	8.31	83.1	0 963
May	1	3.97						0.00	0.000	0.00	0.0	0.000	1 54	0.178	3.02	30.2	0.349
	2	2.12						1.06	0.123	2.08	20.8	0.241	3.36	0.389	6 59	65.9	0.763
	3	2.30						0.88	0.102	1.73	19.0	0.200	3.16	0.366	6.20	68.2	0.718
Jun.	1	4.00						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	2	1.37						1.31	0.152	2.57	25.7	0.298	3.08	0.356	6.04	60 4	0.698
	3	0.86						1.82	0.211	3.57	35.7	0.414	3.48	0.403	6.82	68.2	0.790
Jul.	1	1.60						0.87	0.101	1.71	17.1	0.198	2.28	0.264	4.47	44.7	0 518
	2	4.00						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	3	1.26						1.20	0.139	2.35	25.9	0.273	2.34	0.271	4.59	50.5	0 531
Aug.	1	1.43						0.81	0.938	1.59	15.9	1.839	1.70	0 197	3.33	33.3	0.386
	2	0.71						1.53	0.177	3.00	30.0	0.347	2.25	0.260	4.41	44,1	0.510
	3	3.64						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0 000
Sep.	1	1.66						0.67	0.078	1.31	13.1	0.153	1.04	0.120	2.04	20.4	0 235
	2	3.43						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
	3	4.00						0.00	0.000	0.00	0.0	0.000	0.00	0.000	0.00	0.0	0.000
Oct.	1	1.12						1.16	0.134	2.27	22.7	0.263	1.01	0.117	1.98	19.8	0.229
	2	1.96						0.32	0.037	0.63	6.3	0.073	0.00	0.000	0.00	0.0	0.000
	3	0.55						1.74	0.201	3.41	37.5	0.394	0.97	0.112	1.90	20.9	0.220
Nov.	1	1.21						0.74	0.086	1.45	14.5	0.169	0.41	0.047	0.80	8.0	0 092
	2	1.75						0.21	0.024	0.41	4.1	0.047	0.35	0.041	0.69	6 9	0.080
	3	0 58						1.38	0.160	2.71	27.1	0.314	1.00	0.116	1.96	19.6	0 227
Dec.	1	0.10	0.12	0.014	0.24	2.4	0.027	1.84	0.190	3.22	32.2	0.373	1.42	0.164	2.78	27.8	0 322
	2	0.00	1.42	0.164	2.78	27.8	0.322	1.75	0.203	3.43	34.3	2.512	1.59	0.184	3.12	31 2	0.361
	3	0.00	1.75	0.203	3.43	37.7	0.398	1.51	0.175	2.96	32.6	0.343	1.64	0.190	3.22	35.4	0.373

Note: (1) Effecgive Rainfall (See Table 3-1-7)

(2) Diversion Water Requirement = Net Water Requirement/Irrigation Efficiency (0.51)

Table 7. Water Shortage List of Special Years in July

Year	July	Inflow (MCM)	Effective*1) Rainfall (mm)	Diversion Requirement (MCM)	July Shortage (A) (MCM)	Annual Shortage (B) (MCM)	Ratio (A)/(B) (%)
1965	1	2.3	1.8	18.2	0.0		
	2	1.6	2.1	21.6	0.0		
	3	3.8	40.6	15.6	7.8		
	Total	7.7	44.5	55.4	7.8	13.4	58
1967	1	2.1	16.0	15.9 (13.0)	0.0 (0.0)		
	2	4.4	48.6	12.0 (9.8)	5.9 (0.0)		
	3	3.8	13.9	23.9 (19.6)	19.8 (7.7)		
	Total	10.3	78.5	51.8 (42.4)	25.7 (7.7)	34.4 (14.0)	75 (55)
1972	1	3.5	6.7	17.4	0.0		
	2	2.4	64.1	10.7	0.0		
	3	2.6	10.0	25.2	15.7		
	Total	8.5	80.8	53.3	15.7	15.7	100

Note: *1) Weighted Averaged Effective Rainfall.

( ): In case of excepting Mae Pung

Table 8. Method-wize Acreage for the Scheme

Zone No.	Extensive Method				Intensive Method			
	EL	E2	E3	Sub-total	I1	I2	Sub-total	
1.	0	0	482	482	90	443	533	1,015
2.	59	0	428	487	45	245	290	777
3.	441	0	46	487	0	399	399	886
4.	409	0	150	599	55	9	64	623
5.	239	0	463	702	322	359	681	1,383
6.	6	0	336	342	768	497	1,265	1,607
7.	0	0	56	56	206	674	880	936
8.	43	0	14	57	157	686	843	900
9.	106	0	335	441	432	367	799	1,240
10.	9	0	164	173	269	185	454	627
12.	0	2,451	0	2,451	0	0	0	2,451
Total	1,312	2,451	2,474	6,237	2,344	3,864	6,208	12,445
%	10.5	19.7	19.9	50.1	18.8	31.0	49.9	100.0

Table 9. Physical Inputs per Hectare by Crop

		Unit	1 Paddy (Wet Season)	2 Paddy (Dry Season)	3 Peanut (Wet Season)	4 Peanut (Dry Season)	5 Tobacco	6 Soybean	7 Chilli	8 Garlic	9 Sugarcane	10 Orchard -Pineapple-	11 Vegetable -Cabbage-
Present							(Unit: seedling)				(Unit: pieces)	(Unit: shoots)	(Unit: seedling)
1. Seed		kg	76	76	128	158	3,250	34	5	233	28,500	26,200	40,000
2. Fertilizer	Ammonium phosphate	kg	6	95	-	-	-	20	-	35	67	-	170
	Annonium sulphate	kg	-	-	-	-	-	-	370	-	-	160	-
	4-16-24-4(Mg)	kg	-	-	-	-	500	-	-	-	-	-	-
3. Pesticide	Inspecticides	฿	-	34	-	-	497	34	418	203	-	-	678
4. Mechanical Percentage	Cultivation -Animal	% area	80	80	100	100	100	100	100	100	100	100	100
	-Machine	% area	20	20	-	-	-	-	-	-	-	-	-
Without Project													
1. Seed		kg	76	76	128	158	3,250	34	5	233	28,500	26,200	40,000
2. Fertilizer	Ammonium phosphate	kg	6	95	-	-	-	20	-	35	67	-	170
	Ammonium sulphate	kg	-	-	-	-	-	-	370	-	-	160	-
	4-16-24-4(Mg)	kg	-	-	-	-	500	-	-	-	-	-	-
3. Pesticide	Insecticides	฿	-	45	-	-	695	45	585	283	-	-	949
4. Mechanical Percentage	Cultivation -Animal	% area	80	80	100	100	100	100	100	100	100	100	100
	-Machine	% area	20	20	-	-	-	-	-	-	-	-	-
With Project													
1. Seed		kg	50	50	120	120	3,250	33	5	300	14,000	24,700	40,000
2. Fertilizer	Ammonium sulphate	kg	250	375	-	-	-	-	250	250	190	190	375
	Super phosphate	kg	-	100	-	-	-	-	68	68	103	103	103
	Potash	kg	83	-	125	125	-	125	42	42	83	83	63
	4-16-24-4(Mg)	kg	-	-	-	-	600	-	-	-	-	-	-
3. Pesticide	Inspecticides	฿	-	54	-	-	799	54	673	325	-	-	1,092
4. Mechanical Percentage	Cultivation -Animal	% area	70	70	70	70	70	70	70	70	70	70	70
	-Machine	% area	30	30	30	30	30	30	30	30	30	30	30

Table 10. Project Cost Estimates

	Item	Quantity	Units	Costs		
				Foreign	Local	Total
					(฿ 1,000)	
A.	Irrigation & Drainage Systems					
	1. Irrigation systems					
	a. Mae Wang Left Bank Canal	38.40	km	14,917	38,528	53,445
	b. Mae Wang Right Bank Canal	35.29	"	12,019	29,921	41,940
	c. Mae Pung Main Canal	5.61	"	2,463	5,293	7,756
	d. Mae Pung Left Bank Canal	6.52	"	1,660	3,739	5,399
	e. Mae Pung Right Bank Canal	12.30	"	4,031	8,902	12,933
	f. Link Canal	2.00	"	552	1,408	1,960
	g. Lateral Canal Systems	79 65	"	15,775	34,397	50,172
	Sub-total	179.77		51,417	122,188	173,605
	2. Drainage Systems					
	a. Main Drainage Canal (9 routes)	61.00	km	7,213	11,481	18,694
	Sub-total	61.00		7,213	11,481	18,694
	3. Land Acquisitions					
	a. Irrigation system	116.4	ha	–	7,276	7,276
	b. Drainage system	126.6	"	–	7,910	7,910
	Sub-total	243.0			15,186	15,186
	Total			58,630	148,855	207,485
B.	On-farm Development					
	1. Intensive Development Method					
	I1	2,344	ha	19,591	30,275	49,866
	I2	3,864	"	31,191	37,005	68,196
	Sub-total	6,208		50,782	67,280	118,062
	2. Extensive Development Method					
	E1	1,312	ha	4,939	11,751	16,690
	E2	2,451	"	6,549	10,346	16,895
	E3	2,474	"	7,598	17,230	24,828
	Sub-total	6,237		19,086	39,327	58,413
	Total	12,445		69,868	106,607	176,475
C.	O & M Facilities					
	1. Project Head Quarters	1.0	L.S.	1,200	4,800	6,000
	2. O & M Office Improvement	1.0	"	200	800	1,000
	3. O & M Equipment			7,200	800	8,000
	Total			8,600	6,400	15,000
D.	Engineering Administration (10%)			–	25,148	25,148
E.	Physical Contingencies (10%)			13,702	42,780	56,482
F.	Construction Equipment			93,300	4,660	97,960
G.	Consultants Services, Training			23,280	4,770	28,050
	Total (A - G)			267,380	339,220	606,600
H.	Expected Price Escalation (15%)			40,100	50,900	91,000
	Grand Total			307,480	390,120	697,600

Table 11. Equipment, Vehicles for Construction

Item	Quantity	Unit Cost (฿ 1,000)	Total Cost
1. Foreign currency portion			
Tractor, crawler, 140HP	6	1,170	7,020
Tractor, swampy, 140HP	2	1,290	2,580
Scrap-dozer, crawler 6.4m	2	2,190	4,380
Motor scraper, 11 cu.yd.	5	4,280	21,400
Dragline, crawler, 1.20 m	2	4,310	8,620
Backhoe, crawler, 3/4 cu.yd	12	1,380	16,560
Truck, dump, 6 ton	27	340	9,180
Motor grader, 110 HP	4	870	3,480
Roller, tire, 15 ton	5	640	3,200
Truck, water tank	2	300	600
Truck, fuel	1	580	580
Truck, field greasing	1	1,500	1,500
Truck, pick-up 3/4 ton, 4 x 4	10	80	800
Station wagon, 4 x 4	4	250	1,000
Concrete mixer 140L	10	25	250
Sub-total			81,150
Spare parts (15%)			12,150
Total			93,300 (US$4,665,000)
2. Local currency portion			
Transportation	L.S.		1,400
Delivery charge	L.S.		1,860
Others	L.S.		1,400
Total			4,660
Grand Total			97,960

Table 12. Equipment for Operation and Maintenance

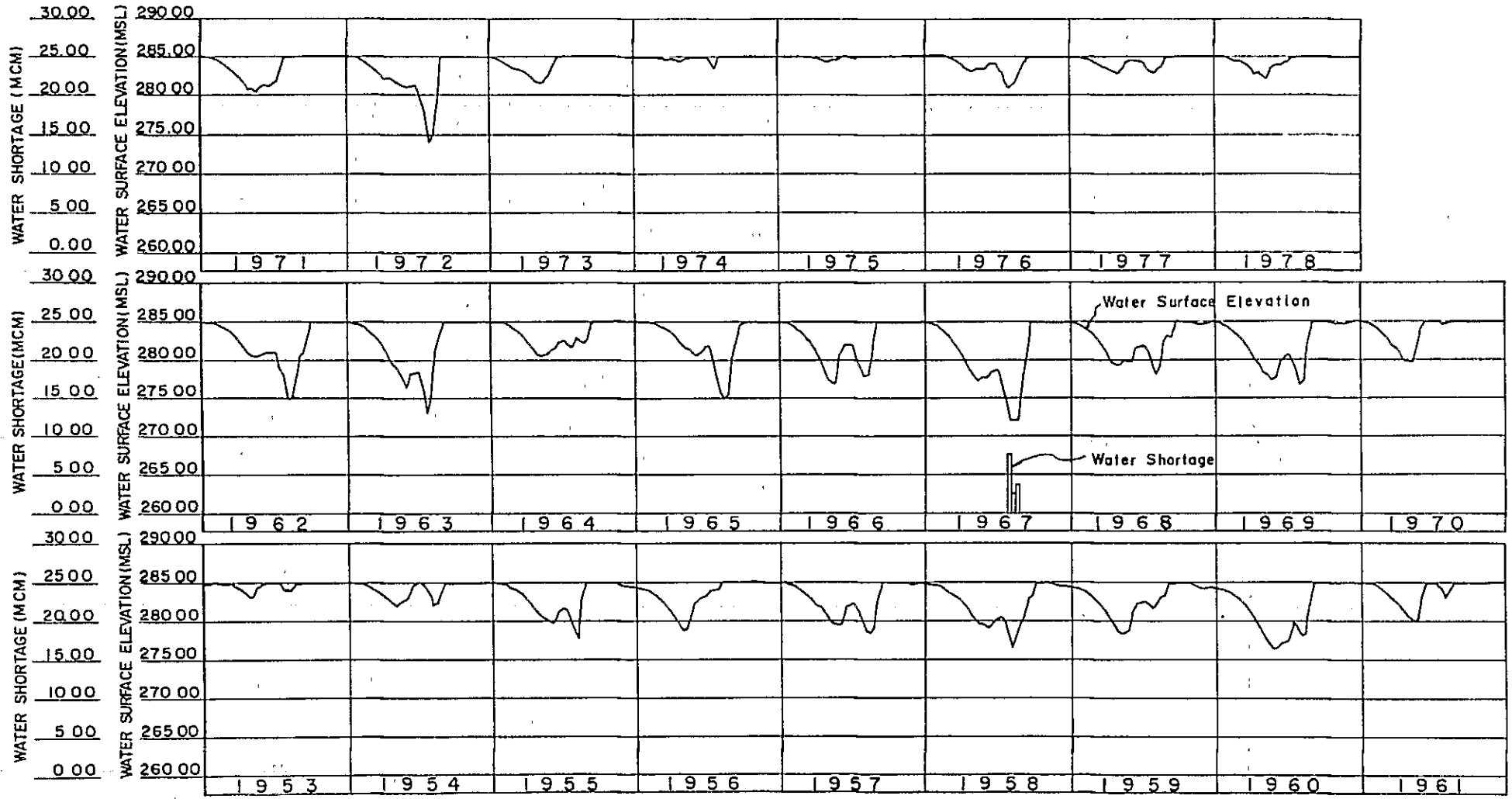
Item	Quantity	Unit Cot (฿ 1,000)	Total Cost (฿ 1,000)
1. Foreign currency portion			
Backhoe 0.35 m	1	920	920
Tractor, crawler 140 HP	1	1,170	1,170
Grader 110 HP	1	870	870
Loader 1.60 m	1	1,060	1,060
Jeep 1,500 cc	4	200	800
Dump truck 6 ton	2	340	680
Pick up truck 0.75 ton	4	100	400
Concrete mixer 140 L	2	25	50
Pump 100mm	5	22	110
Motor cycle 75 cc	30	14	420
Spare parts	L.S.		720
Total			7,200
			(US$360,000)
2. Local currency portion			
Transportation	L.S.		250
Delivery charge	L.S.		300
Others	L.S.		250
Total			800
Grand Total			8,000

Table 13. Cost of Consulting Services and Trainings

A. Consulting Services		
1. Foreign Currency Portion		
1.1 Remuneration (Foreign Consultants = 150 MM)	US$	1,050,000
1.2 Out-of-pocket expenses		55,000
a. International travel expenses		(20,000)
b. Reimbursable cost item & others		(35,000)
I.3 Contingencies		115,000
Sub-total	US$	1,220,000
	(฿	24,400,000)
2. Local Currency Portion		
2.1 Remuneration (Local consulants = 100 MM)	฿	2,000,000
2.2 Living allowance and quarter		1,500,000
2.3 Local communication, transportation		500,000
2.4 Printing of reports		300,000
2.5 Contingencies		430,000
Sub-total	฿	4,730,000
Total	฿	29,130,000
B. Trainings		
I. Foreign Currency Portion		
1.1 International travel expenses	US$	8,000
1.2 Per-diem (US$50 x 8person x 60days)		24,000
1.3 Other cost		8,000
1.4 Contingencies		4,000
Sub-total	US$	44,000
	(฿	880,000)
2. Local Currency Portion		
2.I Preparation expenses	฿	40,000
Sub-total	฿	40,000
Total	฿	920,000
Grand Total	฿	30,050,000

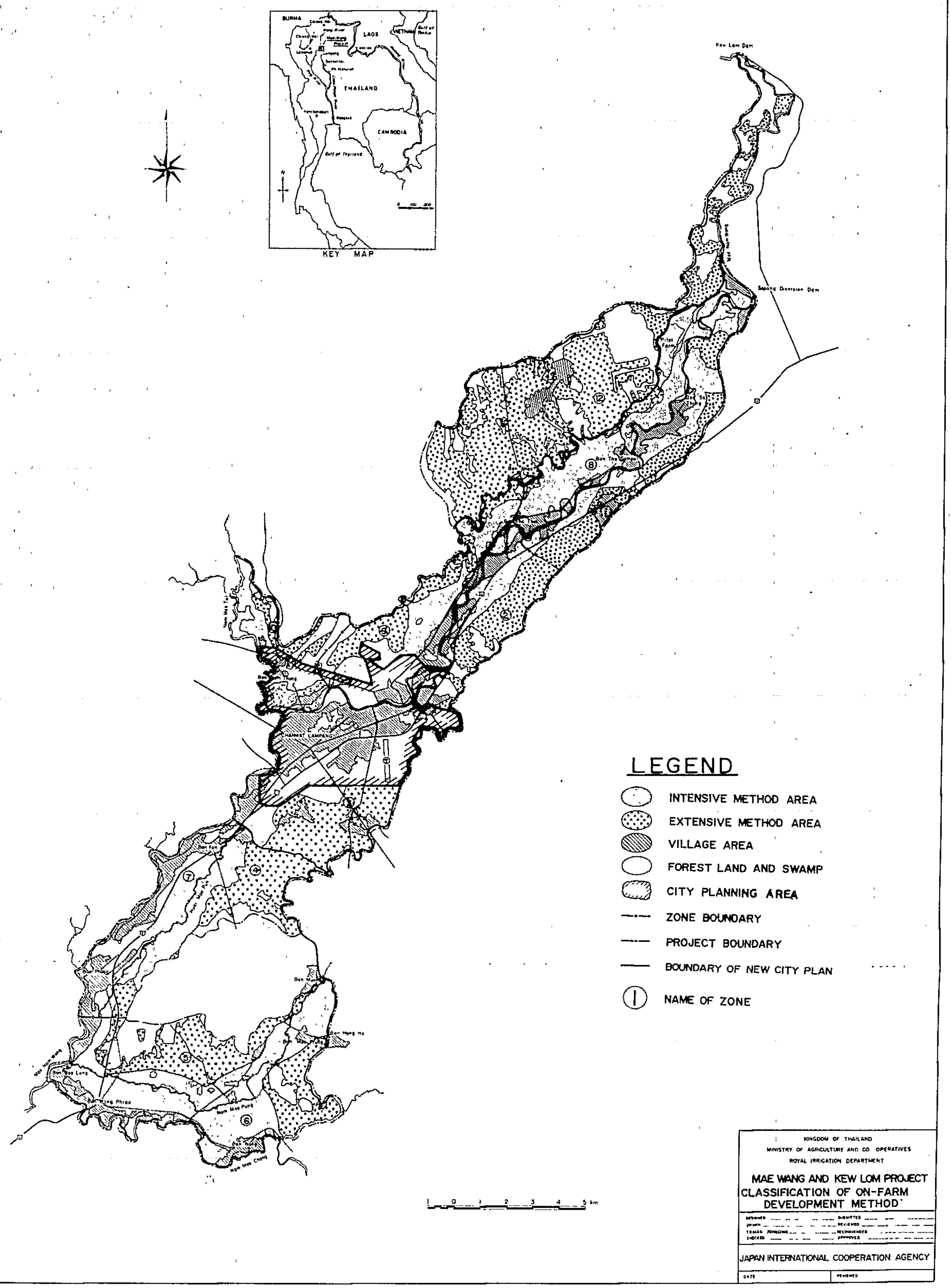
Fugure 3. Water Shortage and Water surface elevation of Dam (Excepting Mae Pung)

(In Case of Revised Operation Rule)



note : Maximum operating water elevation 285 MSL
Minimum operating water elevation 272 MSL

Figure 4. Classification of On-farm Development Method



CHAPTER V PROJECT IMPLEMENTATION AND OPERATION AND MAINTENANCE

CHAPTER V. PROJECT IMPLEMENTATION AND OPERATION AND MAINTENANCE

5.1. Executing Body and Its Organization

The major construction works of the Project are the construction and improvement of the main irrigation/drainage canals, and the on-farm development works (land consolidation works). The Royal Irrigation Department (RID), which has much prominent experience in the similar natured projects to the MK-IADP, should be the executing body of this Project. The organization of the executing body of RID and its supporting organization and agencies is illustrated in Figure 5. The Coordination Committee and the Land Consolidation Committees will be organized at the Central level and the Regional level, respectively.

The Central Coordination Committee will consist of the Secretary to Ministry of Agriculture and Cooperatives (MOAC) as Chairman, Deputy Secretary of MOAC as vice Chairman and project coordinator concurrently, Directors General of RID and Deputy Directors General of RID, DAE, DACP and representatives from other related agencies as committee members. The Committee makes the policies for project execution, administration and the studies on other project related matters to give necessary instructions to the Provincial Coordination Committee.

The Provincial Coordination Committee will consist of the Lampang Changwat governor as chairman, Regional Directors of RID, the representatives from Changwat extension office and agricultural cooperatives, the Project Manager of the Mae Wang-Kew Lom Irrigated Agricultural Development Project, O & M office Manager, etc. This Committee will make representatives to the Central Coordination Committee, execute project works, make plans to promote the comprehensive regional development, study the concrete project plans, and coordinate the agencies concerned in their carrying out various works.

The Central Irrigated Agriculture Committee, supporting the Central Land Consolidation Office, will deal with the legal matters about on-farm development, distribution of lands, land ownership, etc., and look into these matters for making policies.

The Provincial Land Consolidation Office will educate the beneficiary farmers with regard to the Project, deal with legal matters on lands, and give proper advices and guidance to the local land consolidation offices in addition to dealing with the legal matters for project implementation.

The Field Office of the MK-IADP will be located at the Project site and the staff are assigned, such as project manager, office engineer, section chiefes for general affairs, administration, machine O & M, construction works and engineering, in order to smooth execution of the Project. This project manager will be, under the control of the Mae Wang - Kew Lom Project Director, fully responsible for executing the Project works and presiding various committees at the local level.

The general affairs section will be responsible for budgeting, accounting, personnel matters, procurement and other miscellaneous matters. The engineering section will be in charge of performing the necessary topo-surveying for survey and design of major facilities and on-farm development under the cooperation with RID's Survey Dept. and Design Dept. and arrangement works with cadastral survey. The construction works section will be in charge construction and management of the project works, and preparation of implementation schedule for construction works and machine operation program, and construction supervision and inspection of the contract basis works. The machine O & M section will be responsible for carrying out O & M of the RID's construction machinery, materials and their supply/repair, and furthermore preparing the mobilization schedule of the machinery to the RID Machinery Division and the regional machinery offices along with the instructions by the construction works section for smooth progress of the works. The Project Supporting Section will be in charge of keeping records of the progress of civil works and agricultural development during the course of execution of the project works, and carrying out upbringing and strengthening the water management and farmers' organization, extension services in cooperation with related agencies.

5. 2. Coordination with Other Organization and Agencies

The agriculture practised in the Project Area has been under the considerably intensive farm management as compared with that in other places in Thailand and recently tended to employ the dry season cropping with increasing cropping ratio. The Project plan was formulated with seven-year construction period and the full development in target yield attainment at five years after completion of the construction works. The more comprehensive farmers' education and training are required for generating much better effect from the Project on the basis of well developed farming techniques and rather high farm production currently available in the Area. The Project Executing and Assessing Meeting should be held twice a month for realization of the Project, studying the issues to be proposed to various committees at Central or Provincial level, responding properly to the instructions by the Central Committee, and coordinating the works among various local committees and agencies as well as assessing their results.

The Executing and Assessing Meeting will consist of the RID's Project Manager as Chairman, the representatives of the Local DAE and DACP officers, Mae Wang O & M Office chief, Kew Lom O & M office chief, and the local land consolidation office chief, and from the BAAC Lampang Branch Office Manager, the Project Manager of Lampang City Planning Project and the Project Manager of Settlement Scheme could attend the meeting from time to time. Furthermore the consultants staff concerned and RID Regional Director could attend it as observers, if necessary.

In this meeting, the following matters will be discussed for deepening mutual understanding and assessing the actual result, implementation schedule, extension services, upbringing of the cooperatives, farmers' organization, exproposition for the land consolidation works, education and training about water management techniques, and other project related works and their progress and coordination among each others' works for smooth development. If encountering the difficult problems to solve by itself or some issues beyond its control in terms of policy making and legal matters, the meeting can make representations to the higher-level committees concerned to have their adequate instructions. This kind of meeting is quite indispensable to secure the smooth progress of the works.

The meeting should consult with the authorities concerned with the other project of the Mae Chang Dam project, the Lampang City Planning Project, and the Settlement Scheme so as to keep close coordination of the progress of their works. The RID's Project Manager should keep close contact with the field office chief of the Project to have the Project smoothly administrated and promoted with his advices.

5. 3. Implementation Programme

Implementation of the Project will contain the following six work items as shown in Figure 6, surveying and design, construction works, establishment of the field office, procurement of machinery and equipment, agri-supporting services and consultants services. The time schedules of the respective work items were worked out on the basic concept mentioned below.

(1) Surveying and design

The existing Project topo-maps, which were prepared about 10 years ago, have some discrepancies with present condition in land use to have been changed since then by developments or reclamation. The on-farm development planning essentially requires the cadastral maps as basic maps, and thereby aerial photogrammetry, level surveying and cadastral surveying should be carried out to cover the Project Area. On top of the above surveyings, the canal alignment surveyings should be made as well.

It will take about two years to map the topo-maps and cadastral maps from the aerial photos developed from the above aerial photogrammetry. Therefore, commencement of the construction works will be in the third project year, even if the design works are started from the second project year according to the proposed implementation programme. Under such conditions, the survey and design works should be possibly completed by the end of the fiscal year before the implementation is started.

(2) Construction Schedule

The construction works will be implemented starting with the areas where quick yielding of the Project can be anticipated. In considering the fact that the construction and improvement works of the infrastructural facilities are closely related to the on-farm development works, and also the construction works of structures and on-farm for one certain zone, in principle, should be carried out within the same year. The construction works will be carried out during the dry season in most cases. However, since the dry season cropping ratio in the Project Area has reached as high as about 30 percent, the construction works should be implemented in careful consideration for minimizing the adverse effect of the works to the cropping. Especially, the improvement of the main canal on the left bank of the Wang River, where the dry season cropping has been practised at higher level than the other areas; therefore, the contract basis works was planned to complete the works within one year.

As a general rule, the construction works for on-farm development will be implemented in following immediately after the major facilities construction, but those for the Mae Pung area including zone No.5 and No.6 areas planned to be implemented in the final stage of the programme in due consideration of the relation with the construction of the Mae Chang Dam and canals under the Mae Chang Dam Project.

The entire construction period was proposed at five years in taking into account the quantity of machinery to be procured, the actual results obtained in other projects in Thailand, staffing position of RID, trend of budgetary support in Baht, etc.

(3) Establishment of the field office

The construction works of the field office building will have been completed by the second project year, including main building and other facilities to be attached thereto. The Mae Wang O & M office will be provided in the existing Mae Wang office building with some available space to be expanded and the expansion works will be carried out in the sixth project year.

(4) Procurement of machinery and equipment

The construction machinery and equipment to be procured for the force account basis works should be ready for operation before the third project year when the full-scale construction works are started, and thereby, necessary procedures such as tender documents preparation, tender announcement, tender opening, evaluation and contracting will be finished by the first quarter term of the second project year at the latest, so as to spare about 12 months delivery period between contracting and starting operation.

(5) Agricultural supporting services

The agricultural supporting services such as extension of farming techniques, strengthening of cooperative activities and training for water management techniques will be rendered from the second project year, and it is desirable to render continuous services even after project works completed, if necessary. The collection of water charges and allocated cost to farmers will begin from the sixth project year in principle.

(6) Consultants services

Consultants services for assisting the Thai officials concerned in surveying, design, preparation of tender documents, etc. will necessarily begin in the fourth quarter term of the first project year. An expert will be dispatched to the field to assist the Thai counterparts in establishing the agricultural supporting service programme which is to be implemented from the second project year, and the consultants personnel concerned will render services up to the completion of the Project works.

5. 4. Operation and Maintenance (O & M) of Facilities

5. 4. 1. O & M Organization

(1) O & M organization of main facilities

There are existing two O & M offices under the administration of the RID in the Project Area, the Mae Wang O & M office and the Kew-Lom Dam O & M office. The Mae Wang O & M office covers the Mae Tha area (zone No. 11), the area outside the Project Area. The Mae Pung area (zone No. 5 and No. 6) of the MK-IADP Area will be transfered to be under the control of the Mae Chang area O & M office in future, when the planned Mae Chang Dam Project is completed at the upperstream of the Chang River in relating to this MK-IADP. In this study, however, the proposed O & M organization included the Mae Pung Area under the administration of this Project as transitional treatment untill the Mae Chang O & M office will start functioning. On the other hand, the Kew Lom Stage II area will be involved in the Kew Lom area under its O & M office control in future as illustrated in Figure 7, because the said area will become commanded by the same irrigation system as that of the zone No. 12 after completion of construction works of the related irrigation facilities in FY 1980.

The facilities provided and to be provided in the Project Area will be in the direct control of the Mae Wang O & M office manager under the Regional Director of the RID. The Kew Lom Dam O & M office will be responsible for releasing the water to the respective beneficial areas at the planned amount requested by the Mae Wang O & M office and for maintenance of the Dam.

The Mae Wang O & M office will provide five sections of general affairs, agri-supporting services, O & M, machinery and engineering under the Project manager. The O & M services will be practised by four personnel to be assigned as water masters by one for every irrigation system in the O & M section. The water masters will supervise zonemen to be assigned by one for every 800 ha (5,000 rai) and water-and canal-tenderes assigned by one for every 320 ha (2,000 rai) and gate tenders.

(2) O & M organization for on-farm facilities

The O & M and water management for the on-farm facilities will be carried out by beneficiary farmers themselves under guidance and training of the RID staff concerned.

The RID will be in charge of the O & M of the irrigation facilities up to the CHO* provided at every main and lateral canals. One CHO commands 50 - 80 ha of the irrigation areas. Therefore, the farmers' groups will be responsible for carrying out O & M and water management for the facilities downstream of these CHO. In principle, one farmers' O & M group is desirable to be organized by farmers belonging to the same irrigation system.

Under the conditions, one group will consist of about 50 farmers, among whom one farmers' foreman and one common irrigator will be selected. The farmers' foreman will be in charge of not only carrying out O & M of the on-farm facilities but concurrently coordinating the works among extension agents, cooperatives, and the member farms. Figure 8 shows that every one of 240 farmers' groups should enter the membership of the Irrigation Water Users' Association by the irrigation system which the respective farmers groups are belonging to, so as to expand and strengthen the existing water users association as well as to reinforce the united organization in the region.

5. 4. 2. Operation and Maintenance and Management

The Mae Wang O & M office manager (hereinafter called the Manager) will take a responsibility to make report to the Regional Director of RID in Lampang in

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* CHO: constant-head orifice.

regard to irrigation water requirements and cropping programme to cope with the progress of the Project development and to study and execute various matters such as water utilization programme, repair and improvement of flood control facilities, and other under the close consultation with the Kew Lom Dam O & M office manager.

In preparing these plans, the Manager can assign the engineering staff to make design and implementation for repairing and improving the facilities including canals. The machinery section will be responsible for operation and maintenance of the machinery and vehicles to be held by the office and making plans for mobilization of the machinery. The general affairs section will be in charge of general matters such as budgeting, accounting, personnel affairs and management of the office properties.

The agricultural supporting section should play an important role in making cropping plans by the areas, coordination works with other agencies and offices, planning for farmers' education and training, carrying out yield survey, etc. The O & M section will be responsible for carrying out water management and general O & M of the facilities along with the O & M guideline mentioned below.

The water masters assigned to every irrigation system will be responsible for giving guidance and supervision of the zonemen and canal and gate tenders in the respective areas in charge.

The major duties to be performed are shown as follows:

i) In consulting with the agricultural supporting section staff on the cropping pattern suitable to the respective areas, the irrigation requirements shall be determined.

ii) The water to be supplied shall be checked and controlled at the diversion points on whether the water is conveyed in the amount of the determined irrigation requirement.

iii) The discharges shall be measured to take records on the supply basis and the data should be prepared for collecting water charges.

iv) The quarterly reports shall be prepared covering records on water management, particularly irrigated lands in listing the irrigated acreages in both of the dry and the wet seasons.

v) The guidance and supervision shall be given to farmers' foreman and common irrigators about water management and O & M of the on-farm irrigation facilities and roads.

The water and canal tenders should assist the water masters in carrying out O & M of on-farm facilities for proper water distribution of the area in charge and giving guidance to the farmers' groups, and besides the above, the said tenders are responsible for taking records of diversion water amount at every division boxes to make report to ten water masters.

The O & M of the on-farm facilities should be carried out by farmers' foremen and water masters, and also will be responsible for making plans of proper water distribution, and regular repair improvement of on-farm irrigation facilities and roads to be implemented in cooperation with farmers concerned.

5. 5. Consultants Services

The RID is rich in its experiences with capable staff in planning, designing and implementing of the irrigation/drainage development and improvement project and on-farm development projects. Recently, however, the on-farm development or irrigation/drainage development projects have been increasing in number so rapidly that the well-experienced officials cannot fully cover these works. Under the circumstance it is considered necessary that consultants personnel prominent in the fields of planning, detailed designing, construction supervision, and agricultural supporting services, etc. assist the government staff in their execution of the Project works.

The consultant staff to be assigned in this Project shall total 250 man-months, including about one hundred man-months of local staffs, by the engineer who can manage the general project works, irrigation/drainage engineer, land consolidation engineer, surveyor, hydrologist, mechanical expert, O & M expert, agricultural extension expert, agri-institutional expert, etc. in taking into the account the upbringing of the Thai consultants personnel.

Furthermore, it is planned to dispatch eight Thai government officials to study abroad for two months each in the fields of designing, implementation, land exchange procedures, collection of water charges and farmers allotment, etc. for the Project execution.

The consultants services will play a vitally important role in the Project particularly in its initial stage of implementation, and therefore, their services are planned to be started in the second project year.

Figure 5. Proposed Organization of Project Implementation

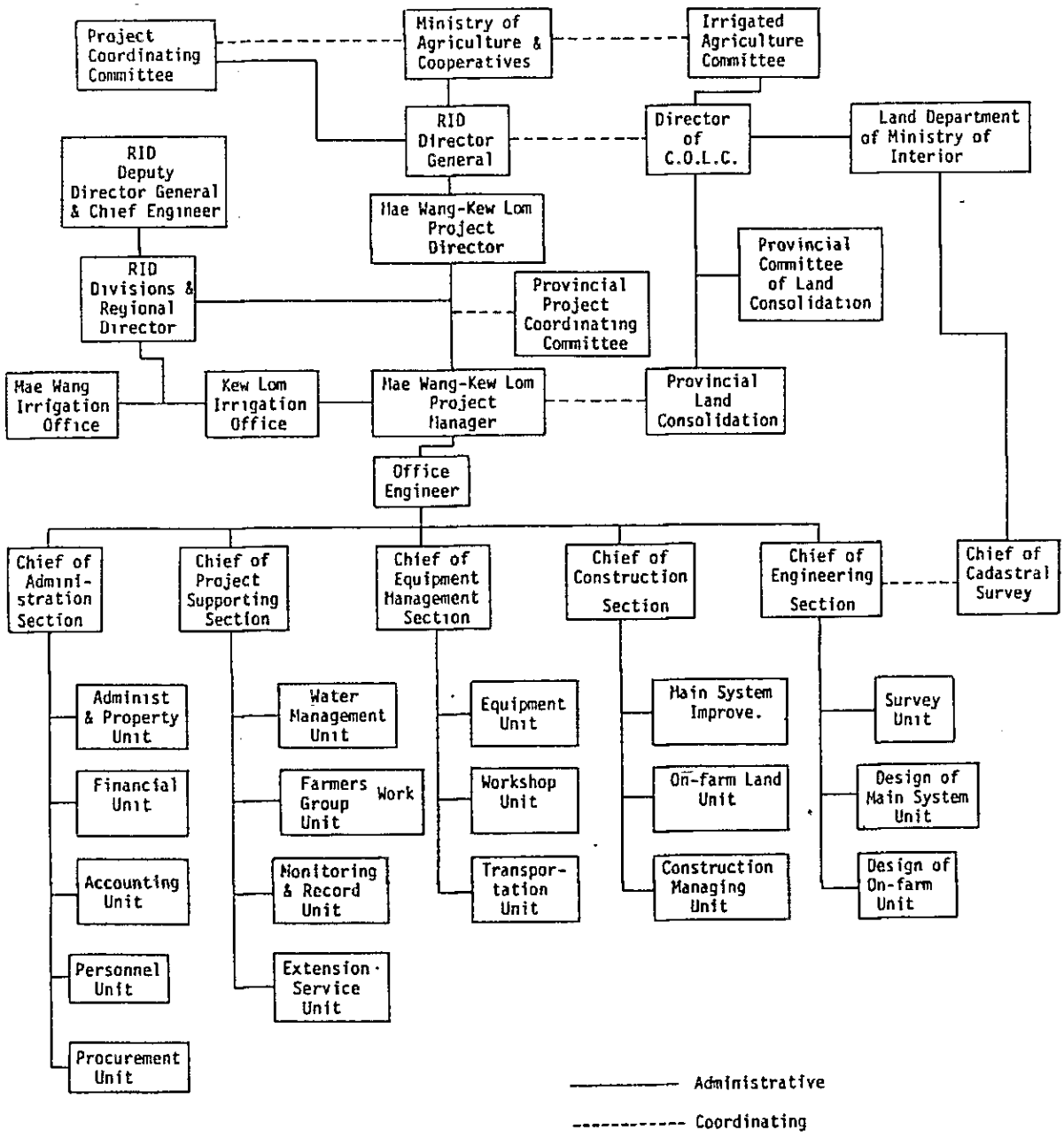


Figure 6. Project Implementations Schedule

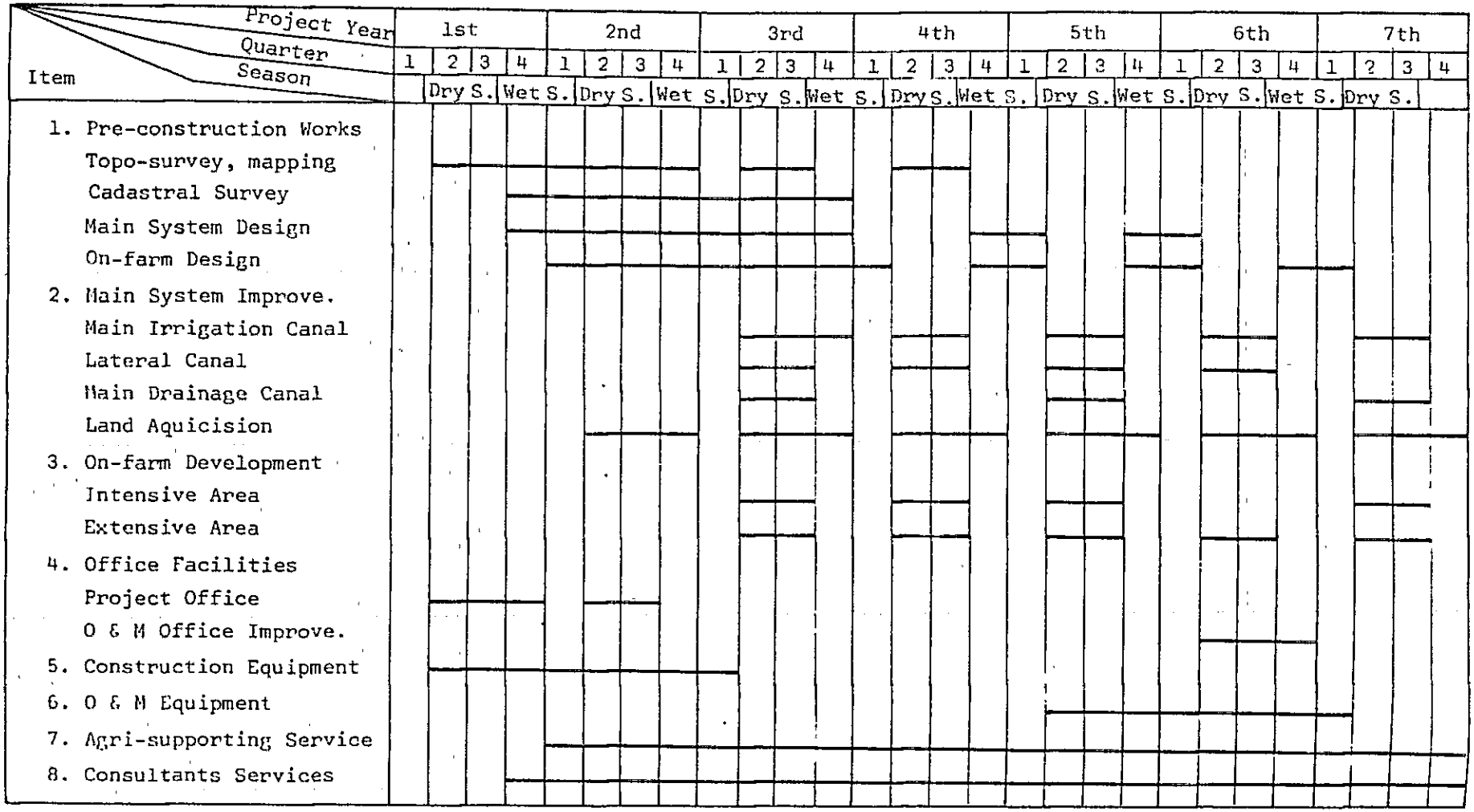


Figure 7. Proposed Organization on Operation & Maintenance

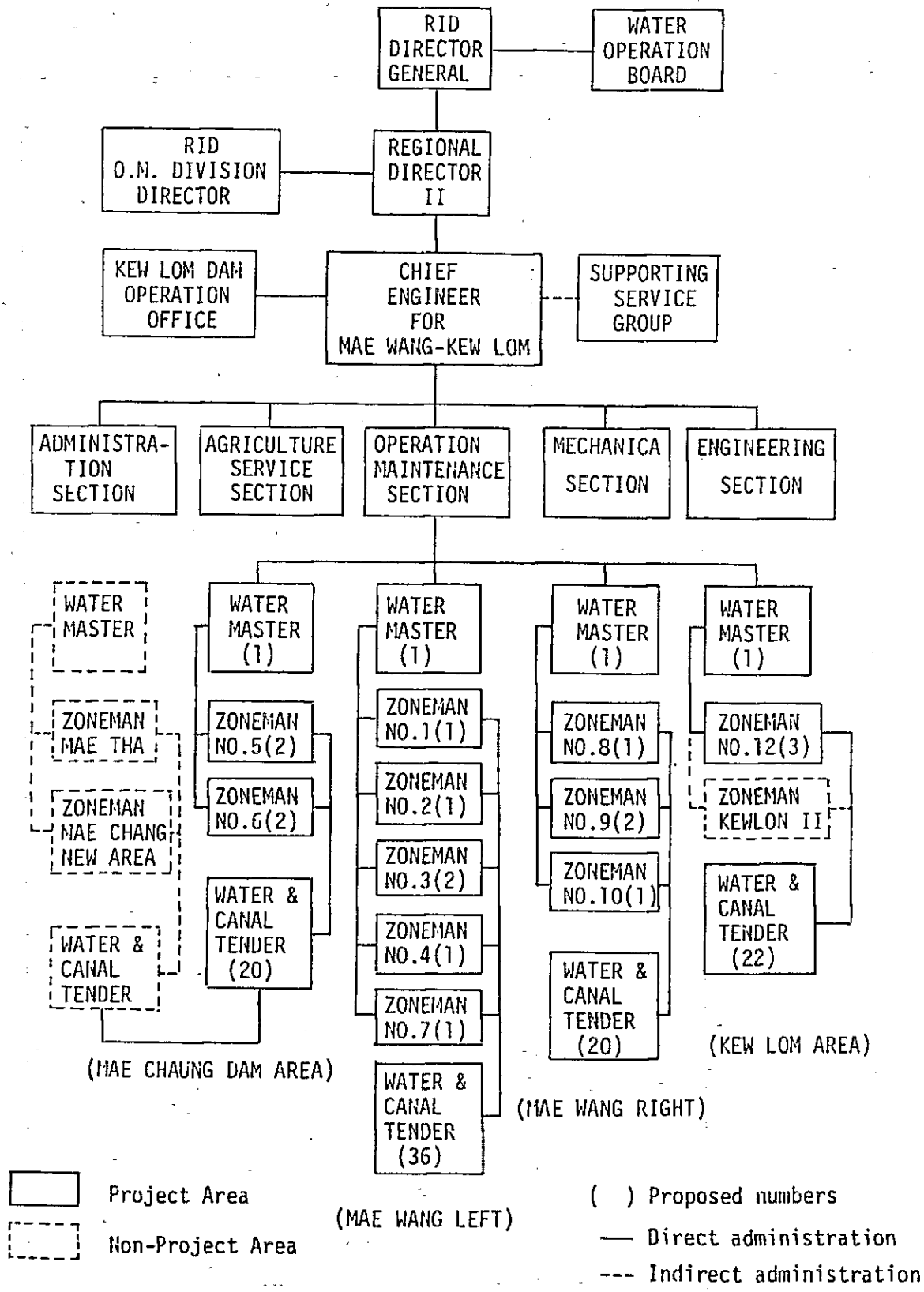
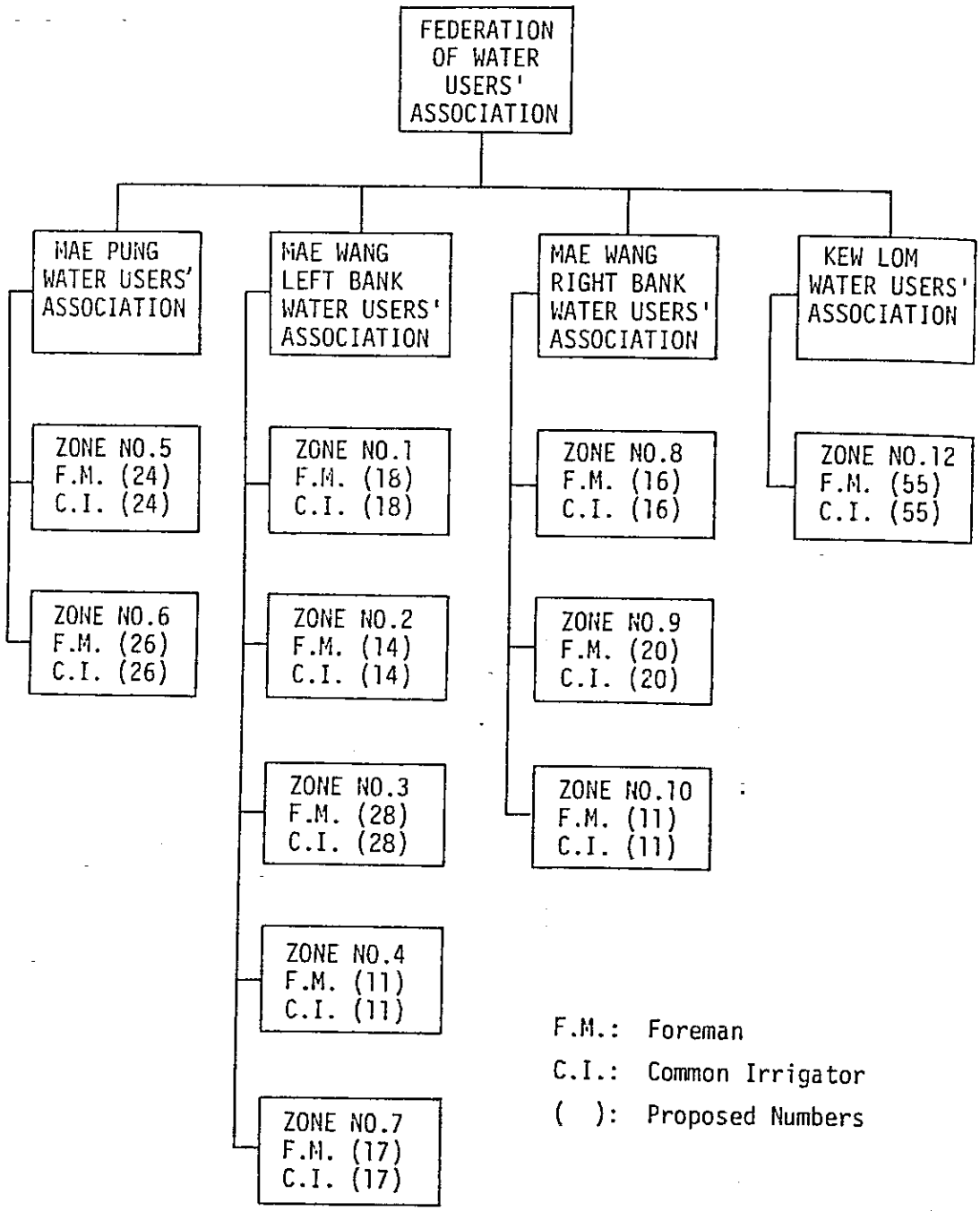


Figure 8. Proposed Farmers' Organization on Operation and Maintenance



CHAPTER VI PROJECT EVALUATION

CHAPTER VI PROJECT EVALUATION

6. 1. Economic Evaluation

6. 1. 1. Economic Evaluation and Development Method

As discussed in Chapter 4, the water resources of the Project are planned to depend upon the Kew Lom Dam and the Mae Chang Dam. The Mae Chang Dam Project is the Project that the planning and the implementation will be carried out in parallel with the execution of the Mae Wang - Kew Lom Irrigated Agriculture Development Project. Therefore, the economic evaluation of the Project should be made for the Mae Pung area under two different conditions of "without Mae Chang Dam" and "with Mae Chang Dam". Thereby, the economic evaluation was carried out for two cases, the Case I for the impact to the whole Project Area in "without Mae Chang Dam", and the Case II for the impact to be fully generated in "with Mae Chang Dam". In the study of Case II, about 110 million Baht of the construction costs for the Mae Chang Dam and the right main canal were estimated into the evaluation as allotted amount to the Mae Pung area.

6. 1. 2. Benefit

According to the implementation programme of the Project, the construction works will be carried out from the dry season in the third Project year to the dry season in the seventh Project year. Consequently, the benefit will be generated from the wet season in the third Project year.

The project benefit was estimated on the basis of the net incremental income by production increase, involving the increase with the irrigation system completed under the Project. Then, the farm input materials and outputs thereby were evaluated for both "with" and "without" project. In the evaluation, it was assumed to be fifth year after completion of the physical development that the target yields per unit area of the respective crops would be accomplished. Therefore, the Project was designed to reach its full development in 11th Project year from the commencement.

The estimation resulted in generating benefit of 206.42 million Baht (US$ 10.32 million) in the Case I, and 218.53 million Baht (US$10.93 million) in the Case II. The benefit would be generated in the premise of the technical guidance properly rendered to the farmers in "with Project condition". The incremental benefits of the Case I are illustrated in Table 14.

The itemized kinds and required amounts of input materials and expected outputs are described in Chapter 4. The farm gate prices of the crops used for benefit estimation are as follows: (ANNEX 8,Table 8-4)

Farm Gate Prices of Crops (Economic prices)

	1980 (฿/ton)	1990 (฿/ton)
Paddy (dried in husk)	3,630	4,360
Peanut (fresh in shell)	3,200	4,620
Tobacco (fresh)	1,825	2,780
Soybean	8,140	12,350
Chilli (fresh)	4,095	6,210
Garlic (fresh)	8,935	13,560
Sugarcane	300	480
Pineapple	1,920	2,930
Cabbage	2,050	3,100

Wage rate

On the basis of the farm economy survey conducted in the Project Area, the daily wage rate was estimated for the cases of "with project" and "without project". These wages were computed in "the opportunity cost", taking into account the seasonal fluctuation of the farm labor.

6. 1. 3. Economic Internal rate of return

The Economic internal rate of return, taking the Project life by 50 years, was computed in comparing the economic cost and O & M cost to be required in the Project life with the net incremental income for the same period.

The economic cost of the Project was estimated at 448.88 million Baht (US$ 22.44 millions) for the Case I and 530.28 million Baht (US$26.51 millions) for the Case II, respectively. These economic costs can cover only those necessary costs for constructoin materials and others to be required for project implementation, excluding related taxes, duties and those costs to cover the price escalation during the period. The annual O & M cost to be required was estimated at 6.9 million Baht for both the Case I and the Case II, respectively at the time of completion of the Project construction.

In employing the above data, the calculation was made to obtain the economic internal rate of return by 27.1 percent for the Case I (ANNEX 8, Table 8-8) and 25.3 percent for the Case II (ANNEX 8, Table 8-10).

On the other hand, the sensitivity analysis was carried out in taking into account the factors such as cost overrun, delay in benefit generation, etc. to find the economic internal rates of return as follows:

		Case I (%)	Case II (%)
A.	Taking 7 years to accomplish target yield	26.3	24.8
B.	Cost overrun by 10%	25.4	23.7
C.	Combination of A & B	24.7	23.2
D.	Crop price reduction by 10%	24.5	22.8
E.	Combination of A & D	23.9	22.6

6. 2. Farm Economy

6. 2. 1. Selection of Representative Farmers

The two each of model farmers who are supposed to be representative in three farm sizes in the Project Area, were selected. The criteria for this selection are that the average farm size in the Area is 1.3 ha, and 0.7 ha and 2.5 ha are taken as average of the farm below and above the average farm size, and each two farmers are selected from the respective three farm size classes.

The farming pattern is determined as follows:

- o Only paddy cropping
  Paddy + Groundnut, Tobacco, Soybean, Chilli, or Garlic
- o (selective for standard combination)

According to the above data, the farming patterns are designed as follows by model farms.

Model Farm		Farming Patterns
0.7 ha	Model I	Only paddy (Wet + Dry)
	Model II	Paddy + soybean, garlic
1.3 ha	Model I	Only paddy
	Model II	Paddy + groundnut, tobacco, soybean, garlic
2.5 ha	Model I	Only paddy
	Model II	Paddy + groundnut, tobacco, soybean, chilli, garlic

Some of the above model farms have to depends upon the non-farm income to support their livelihood in addition to the farm income. In order to confirm the farm income of these farms on condition of "with project", the following farm income analysis was carried out.

6. 2 2. Farm Income Analysis

First of all, the farm income analysis was made on the cases of present, "without project" and "with project" in regard to the selected model farms in the previous paragrah, and then, the economical capacity was studied on payment of water charges and allotment of the construction cost in case of "with project". The above studies were shown as follows. Refer to Table 15, 16 and 17.

Net Value of Production

Unit: Baht/Year

Model Farm		Present	Without Project	With Project: Before Project Charge	With Project: After Project Charge
0.7 ha	Model I	3.510	4,925	9,255	7,970
	Model II	7,725	10,975	23,330	22,045
1.3 ha	Model I	6,600	9,270	15,445	13,050
	Model II	11,235	17,535	39,070	36,675
2.5 ha	Model I	11,013	16,060	28,320	23,720
	Model II	17,765	28,390	55,455	50,855

(i) At present, the net farm profits earned by the farms of model I & II with 0.7 ha farm size and those of model I with 1.3 ha farm size do not pay to the necessary family living cost of 11,000 Baht per annum* and they are forced to seek for employment opportunity of non-farming works. This has been proved by the fact that many farmers in the Project Area went to the areas outside the Project Area for working in the dry season. If they remain in what they are, they would be forced to supplement their living cost by doing some non-farming works. Contrarily, the farms of Model II with 1.3 ha and those of Model I & II with 2.5 ha can manage their family support without doing side business even at present and in "without project" condition.

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* The farm economy survey revealed that the living cost per family was computed at 10,540 Baht per annum for the farmers with farm size below 1.0 ha, 9240 Baht for the farmer with farm size between 1.0 ha and 1.6 ha, and 12,470 Baht for the farmer with farm size over 1.6 ha, respectively.

(ii) Under the conditions of "with project" in future, the farms with 0.7 ha and those of model I with 1.3 ha -- only paddy cropping at present --would have to selectively grow the crops with higher commercial values and profitability as well as try to raise the cropping ratio, if they would be full-time farming. That is because the farms' will be increased in payment of water charges and allotment of construction cost in "with project" condition in addition to the ordinary expense for family support. And if sticking to paddy cropping only in both the dry and the wet seasons, they will have to engage themselves in non-farming works to earn the additional income to meet the expenditure to be expected in "with project".

As for farms of model II with 1.3 ha and of I & II with 2.5 ha, however, they would generate surplus of household economy after paying the allotment of construction cost and living cost required.

The allotment of construction cost to be borne by farms after completion of the Project, was assumed on the following concept. The land leveling cost out of the on-farm development cost shall be totally borne by farms, and 10 percent of the development cost of public facilities, at least shall be borne by farms in refunding annually even installments for 15 years at 12 percent annual interest with three-years grace period. The water charges estimated shall include the O & M cost for the on-farm facilities.

The repayment by farmers will be 1,630 Baht per hectare for the on-farm development and 210 Baht per hectare for the O & M services. (ANNEX 8, Table 8-15)

6. 3. Expected socio-economic impacts

The Project, when realized, will directly or indirectly affect not only agricultural production but also various other fields. The benefit analysis in this study took up only the incremental benefit to be generated by agricultural production increase as an objective. On top of the above, however, the following benefits would be generated from the Project; firstly, employment will be increased by implementation of the Project, secondly, the agri-business will be expanded by active marketing and processing of input and output materials which will be increasingly required and produced in "with project" conditions, thirdly, the increase in farm income will result an increase of disposable income, and fourthly, the security and stability in peoples' life will be assured from the result mentioned in the above first to third.

Table 14. Incremental Benefits, Case I

Unit: Million Baht

Year	Without Project				With Project				Incremental Benefits
	Gross Value of Production	Production Cost		Net Value of Production	Gross Value of Production	Production Cost		Net Value of Production	
		Input Material Costs	Labor Costs			Input Material Costs	Labor Costs		
1982	226.94	48.21	40.43	138.30	226.94	48.21	40.43	138.30	0
1983	235.53	48.92	40.37	146.24	225.05	39.75	46.03	139.27	6.97
1984	244.12	49.63	40.31	154.18	244.22	45.48	51.62	147.12	7.06
1985	252.72	50.34	40.25	162.13	309.93	57.63	57.22	195.13	33.00
1986	261.31	51.05	40.20	170.06	398.15	75.61	62.81	259.73	89.67
1987	269.91	51.76	40.14	178.01	482.15	93.42	68.41	320.32	142.31
1988	278.50	52.47	40.08	185.95	559.14	111.37	74.00	373.77	187.82
1989	287.10	53.18	40.02	193.90	591.43	121.65	79.60	390.18	196.28
1990	295.69	53.90	39.96	201.83	617.42	128.43	85.19	403.80	201.97
1991	304.29	54.47	39.90	209.92	638.21	133.17	90.79	414.25	204.33
1992	312.88	55.04	39.84	218.00	656.94	136.14	96.38	424.42	206.42

Table 15. Farm Budget - 0.7 ha (4.4 rai) Farm

Item	Unit	Present				Without Project				With Project			
		I		II		I		II		I		II	
		Wet Season	Dry Season	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Cropping													
Paddy	ha	0.7	0.2	0.7	-	0.7	0.2	0.7	-	0.7	0.6	0.7	-
Peanut	ha	-	-	-	-	-	-	-	-	-	-	-	0.1
Tobacco	ha	-	-	-	-	-	-	-	-	-	-	-	0.1
Soybean	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.1
Chilli	ha	-	-	-	-	-	-	-	-	-	-	-	-
Garlic	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.2
Intensity	%	129		129		129		129		186		186	
Gross value of production	฿	5,550		9,970		7,200		14,315		15,235		32,355	
Production cost exclude labor	฿	1,960		2,160		2,170		3,210		5,680		8,600	
Hired labor	฿	-		-		-		-		-		-	
Land tax[a/]	฿	35		35		55		55		55		55	
Interest[b/]	฿	45		50		50		75		245		370	
Net value of production before project charge	฿	3,510		7,725		4,925		10,975		9,255		23,330	
Project charge													
On-farm development cost[c/]	฿	-		-		-		-		1,140		1,140	
O & M Cost[d/]	฿	-		-		-		-		145		145	
Net value of production after project charge	฿	3,510		7,725		4,925		10,975		7,970		22,045	

* Rounded to nearest ฿5.

a/ Present ฿ 8/rai, future ฿ 12/rai

b/ Interest charge at 6% (1% per month). It is assumed that 50% of farmers borrow 80% of their cash needs at present and 80% would borrow 90% of their cash needs in future.

c/ ฿ 1,630/ha d/ ฿ 210/ha

Table 16. Farm Budget - 1.3 ha (8.1 rai) Farm

Item	Unit	Present I Wet Season	Present I Dry Season	Present II Wet	Present II Dry	Without Project I Wet	Without Project I Dry	Without Project II Wet	Without Project II Dry	With Project I Wet	With Project I Dry	With Project II Wet	With Project II Dry
Cropping													
Paddy	ha	1.3	0.4	1.3	-	1.3	0.4	1.3	-	1.3	1.0	1.3	-
Peanut	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.1
Tobacco	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.2
Soybean	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.3
Chilli	ha	-	-	-	-	-	-	-	-	-	-	-	0.1
Garlic	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.3
Intensity	%	131		131		131		131		177		177	
Gross value of production	฿	10,465		16,600		13,575		23,685		26,860		57,935	
Production cost exclude labor	฿	3,710		5,175		4,110		5,915		10,015		15,575	
Hired labor	฿	-		-		-		-		875		2,525	
Land tax[a/]	฿	65		65		95		95		95		95	
Interest[b/]	฿	90		125		100		140		430		670	
Net value of production before project charge	฿	6,600		11,235		9,270		17,535		15,445		39,070	
Project charge													
On-farm development cost[c/]	฿	-		-		-		-		2,120		2,120	
O & M cost[d/]	฿	-		-		-		-		275		275	
Net value of production after project charge	฿	6,600		11,235		9,270		17,535		13,050		36,675	

* Rounded to nearest ฿5

a/ Present ฿ 8/rai, future ฿ 12/rai

b/ Interest chared at 6% (1% per month). It is assumed that 50% of farmers borrow 80% of their cash needs at present and 80% would borrow 90% of their cash needs in future

c/ ฿ 1,630/ha

d/ ฿ 210/ha

Table 17. Farm Budget - 2.5 ha (15.6 rai) Farm

Item	Unit	Present				Without Project				With Project			
		I		II		I		II		I		II	
		Wet Season	Dry Season	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Cropping													
Paddy	ha	2.5	0.8	2.5	-	2.5	0.8	2.5	-	2.5	20.0	2.5	-
Peanut	ha	-	-	-	0.2	-	-	-	0.2	-	-	-	0.4
Tobacco	ha	-	-	-	0.2	-	-	-	0.2	-	-	-	0.5
Soybean	ha	-	-	-	0.2	-	-	-	0.2	-	-	-	0.5
Chilli	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.3
Garlic	ha	-	-	-	0.1	-	-	-	0.1	-	-	-	0.3
Intensity	%	132		132		132		132		180		180	
Gross value of production	฿	20,293		29,335		26,315		41,575		52,630		95,530	
Production cost exclude labor	฿	7,205		9,445		7,980		10,840		19,620		27,370	
Hired labor	฿	240		1,290		450		1,680		3,660		11,340	
Land tax[a/]	฿	125		125		185		185		185		185	
Interest[b/]	฿	175		225		190		260		845		1,180	
Net value of production before project charge	฿	11,013		17,765		16,060		28,390		28,320		55,455	
Project charge													
On-farm development cost[c/]	฿	-		-		-		-		4,075		4,075	
O & M cost[d/]	฿	-		-		-		-		525		525	
Net value of production after project charge	฿	11,013		17,765		16,060		28,390		23,720		50,855	

* Rounded to nearest ฿

a/ Present ฿ 8/rai, future ฿ 12/rai

b/ Interest charged at 6% (1% per month). It is assumed that 50% of farmers borrow 80% of their cash needs at present and 80% would borrow 90% of their cash needs in future

c/ ฿ 1,630/ha

d/ ฿ 210/ha

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