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PROJECT NOTE NO. 5

PILOT AREA 2

OPERATIONS RESEARCH RESULTS - 1981/82 - LAM NAM OON

LAM NAM OON INTEGRATED RURAL DEVELOPMENT PROJECT

****

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SEPTEMBER, 1982

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FOREWORD

The Louis Berger International, Inc. advisory team at Lam Nam Oon produces various kinds of informational and analytical data. These comprise: Quarterly Reports; Technical Notes; Project Planning Notes; Project Notes: and advisory memoranda.

We collaborate very closely with Thai personnel at Lam Nam Oon; and we regard their efforts as the foundation-stones for the future development of a prosperous Lam Nam Oon irrigated area. Much inventiveness and initiative marks the efforts of the Royal Thai Government's personnel at Lam Nam Oon. We try to identify, support, report about, and improve such efforts.

We also believe that some of the innovations introduced at Lam Nam Oon may make a mark upon the history of applied integrated rural development in an irrigation setting.

Accordingly, The Center for Rural Development, which is a Division of the Louis Berger Group of companies, issues this Report as Project Note Number 5.

Currently, in 1982, the Center supports ten major rural development projects which are funded by the World Bank, the U.S. Agency for International Development, the Asian Development Bank, and other international agencies in Asia, Africa, the Middle East and Latin America.

As a part of it's services to clients and the professional community of those engaged in rural development, the Center releases technical and project information on various aspects of individual projects.

For those interested in Project Note # 5 (Lam Nam Oon) additional copies may be obtained from the Center for Rural Development, c/o Louis Berger International, Inc. 100 Halsted Street, East Orange, New Jersey 07019, U.S.A.

I. INTRODUCTION:

On-farm water delivery systems[1] are absolutely essential to making large-scale irrigation projects function properly in Northeastern Thailand. The rolling terrain and the friable soils dictate that the Royal Irrigation Department design and construct these systems. By so doing, individual farmer-irrigators can better assure themselves that reliable supplies of water are obtainable.

Do big differences exist in management requirements (imposed upon farmer-irrigators), water use efficiencies, and economic returns (for farmer-irrigators) between various designs of on-farm water delivery systems? If so, can they be measured or observed in sufficient intensity so that comparative judgements can be made?

Answers to these and other questions are under research at the Royal Irrigation Department's irrigation project in Lam Nam Oon, Northeastern Thailand.

That project is now entering a construction stage in which on-farm water delivery systems are being designed and built. A total of 1,700 Kilometers of ditch/dykes (canals) serving 12,500 individual farm holdings will be constructed during the 1980-85 period. See Annex A showing present construction plans.

Prior to this stage it has required twelve years for RID to design and construct at Lam Nam Oon those major irrigation facilities which now make it possible to supply the water to each farm holding. An earthen dam required six years for design and construction. It impounds 520,000,000 cu. meters of water comprising the backed-up Lam Nam Oon river and watershed runoff from an area of approximately 50 square kilometers in the adjacent Phuphan mountains. Another six years were required to design and construct over 500 kilometers of cement-lined lateral and sub-lateral canals and install four electrically powered pumping stations at varying high points within the irrigable area. Ultimately, the system is to serve 185,500 Rai or 29,000 Hectares.[2]

Today, in 1982, even as the Royal Irrigation Department designs and installs on-farm water delivery systems at Lam Nam Oon it continues research on what systems might be best suited to local conditions. That research started in the Dry Season (December-May) of 1981/82 at Lam Nam Oon. A specific system, suited to Lam Nam Oon's conditions, has been designed and constructed. It is called the Lam Nam Oon model located at Pilot Area 2. It occupies an area of 2,400 rai (about 38 Hectare) served by the Right Main Canal and a lateral canal 35 Kilometers from the Headgates of the Dam. See Annex A.

1. On-Farm Water Delivery Systems - graded water supply ditches linked to lateral or sub-lateral canals, equipped with turn-outs for each farm, and served by graded drainage ditches.

2. 1 Rai = 0.16 Hectare; 1 Hectare = 6.25 Rai; 1 Acre = 2.5 Rai

The Lam Nam Oon on-farm water delivery system is aimed at successfully dealing with the extensive Perched Water Table[3] and High Water Table[4] conditions at Lam Nam Oon as well as the friable, easily eroded, and low organic matter soils of that area. It has very specific design characteristics:

* It's ditch/dykes convey smaller volumes of water along shorter canals to fewer farmer-irrigator holdings. This requires small cross-sections of canals at less cost. It results in less water flowing into areas with extensive Perched Water Tables and poor natural drainage conditions. The shortened canals also do not lose much water by percolation and seepage through the friable soils.

* The design reduces the number of farmer-irrigators who have to plan for the use of the irrigation water.

* The design contains Quaternary sections which are paired in area. This allows for controlled rotation of water amongst the different groups of farmer-irrigators within the entire area. Such a feature allows flexibility in the use of different farms to grow different crops during the same irrigation season. It also helps to meet special water management needs during times of water shortages or when localised difficulties are encountered with the Perched Water Table or drainage.

* Overall systems water management efficiency is promoted by reducing the number of Constant Head orifices (CHO's) releasing water from laterals and sub-laterals into on-farm water delivery ditch/dykes (canals).

* Gated Proportional Division Boxes are used. These allow flexibility in rotation of water under conditions of limited availability. Under conditions of continuous flow they distribute water to Quaternary sections automatically, as designed for each area.

* The design is fitted to the contours of the land and there is no land levelling. Hence, the fragile Northeastern topsoils and their organic matter are undisturbed. This should result in the maintenance as well as improvement of crop yields in the area, particularly if some degree of organic soil enrichment and fertilizer use is promoted.

* Because the design uses less water than some other types it is fitted to the extensive Perched Water Table and High Water Table conditions that exist in the Lam Nam Oon area.

3. Subsurface - Drainage problem caused by excess water in the normal root zone extra precautions in irrigation required. Area affected at Lam Nam Oon 97,186 Rai.
4. Less than a meter from surface. Irrigation practices must guard against waterlogging. Area affected at Lam Nam Oon 6,418 Rai.

* In order to adequately test varying densities of water supply, drainage, and road access the area contains three Units of the Lam Nam Oon model. Unit I has the least density, Unit II is moderate, and Unit III has the highest density. Each Unit comprises about 800 Rai or 13 Hectare.

II. Operations Research at Lam Nam Oon

The Royal Irrigation Department has long been concerned about examening the efficiency and suitability of different on-farm water delivery systems that might be installed at Lam Nam Oon.

This concern led it, in 1977, to discuss the subject with the United States Agency for International Development(AID) at Bangkok. As a result, it was agreed that AID would help to finance an integrated rural development technical assistance effort at Lam Nam Oon. Much emphasis would be placed upon organizing and conducting Operations Research.

A $4,500,000 Loan was negotiated with AID; and one important component of that loan concerned the employment of a consultant firm to assist in the Operations Research.

The consultant firm of Louis Berger International, Inc. was selected. It's contract obligated it, among other requirements, to comply with a 14-page detailed Scope of Work for Operations Research at Lam Nam Oon.

The consultant team began to arrive at Lam Nam Oon in November, 1979. By that time the Royal Irrigation Department had already been engaged for two years in designing and constructing one on-farm water delivery system at Lam Nam Oon.

The one selected and already installed or designed at that time was the Chanasutr Land Consolidation model. This system was based on RID experience earned by the Royal Irrigation Department, with technical advice from the Netherlands, during the years from 1968 to 1972. The model was designed for application to the deep topsoils and relatively flat terrain of Thailand's central plains flood basin.

After examening the 4,000 rai of either constructed or designed Chanasutr on-farm water delivery system for Lam Nam Oon, the Berger advisory team recommended against widespread application of that system to the Lam Nam Oon area. It did this after studying the particular soil, terrain, and water conditions at Lam Nam Oon.

The Berger Team found that earlierstudies of the area (Engineering Consultants, Inc. ECI Report) were valid in terms of observations made about thin topsoils, low organic matter, a Perched Water Table and a High Water Table. Furthermore, the storage capacity of the Lam Nam Oon dam was such that only those kinds of crops that did not require too much water for irrigation should be planted. Since the water supply was to be limited, it also became important that the on-farm water delivery systems designed would use the least amount of water possible. Also, they had to be designed so that their use could be rotated easily by the farmer-irrigators.

The Chanasutr model did not meet these conditions. The Berger team then examined other models of ditch/dyke on-farm water delivery systems being designed and installed elsewhere in the Northeast by RID. It found that some of these systems were much more appropriate to Lam Nam Oon conditions than the Chanasutr model. Yet, all of them were designed for other terrain, soils, and water table situations. It appeared, therefore, that a special model would have to be designed and tested for Lam Nam Oon.

Thus, the Berger team recommended that a Lam Nam Oon model be developed. Once designed and installed, Operations Research could be applied to this model as well as others that might be constructed at Lam Nam Oon.

As indicated above, based upon the advisory teams recommendations, the Lam Nam Oon model was designed and constructed in 1981 at Pilot Area 2. It contains three different Units; but at the time of the first effort to conduct Operations Research on this model only two Units were completely constructed (I and II).

The advisory team designed an initial Operations Research Protocol (Project Planning Note #1) to govern work in Units I and II during the Dry Season of 1981/82. See Annex B

The research goals and methods for that first Dry Season were held to very simple standards. A number of factors contributed to this decision including:

* It was obvious that only a few farmers would become farmer-irrigators in the two Units during that Dry Season. They had no experience with irrigation for that time of year. The new on-farm water delivery system was mysterious to them. They were not yet organised into water user groups and trained. There were uncertainties about reliable prices for products at fair levels and markets.

* All research work had to be done manually and only with Berger team staff. Digital measuring and computer-related instrumentation is scheduled for installation in the area; but in that Dry Season it was not yet installed. Therefore, all water measurements had to be done daily by hand.

* RID staff was otherwise engaged as the project expanded and so work on studying farmer-irrigator economic returns had to be performed only by Berger staff.

* Because of shortages of staff and equipment as well as the very small area under cultivation within Units I and II a number of research tasks were deliberately postponed. These included: no observations of the ground water table or perched water table conditions, no attention to salinity conditions, no scheduled observation of management problems encountered by farmer-irrigators or Zonemen when operating the system; and no comparative cost studies on construction and operation as between the Units.

III. Organizing and Operating the 1981/82 Dry Season Tests:

The Lam Nam Oon model was designed by Mr. Erroll Coles of the Berger advisory team and Nikom Thongmata of the On-Farm Work section, Design Division, RID. They completed their work in February, 1981. The detailed design criteria appear in Technical Note #1 of Aug. 1980 by Erroll Coles with an accompanying Handbook on Channel Designs for Quaternary Canals by William Bell.

Construction of the model was done at Pilot Area 2 by the RID Construction Division under the field supervision of Surathep Ratanavit. That work was completed for Units I and II by July, 1981.

Initial preparations for the Operations Research began in July, 1981. In that month, selection, identification, and interview of farmer-irrigators in Units I and II occurred. Individuals selected owned farms located either at the beginning, middle or ends of Quaternary canals inside the two Units. Miss Maia Bridgit Dalton, a sociology student from Washington and Jefferson College in the United States, began the initial selections and interviews.

Her initial selection work was followed up by detailed Lao-language interviews conducted by Mr. Anthony Zola after his employment as the rural development specialist on the Louis Berger International, Inc. advisory team in mid-September, 1981. Vichai Snguanpaiboon, The Project Field Director also began to give full R.I.D. support to preparations for the Operations Research.

Concurrently, the System and On-Farm Irrigation Engineer advisor for the team - Mr. William Bell - began preparations for manual measurement of water inputs and drainage from Units I and II. Sets of metal "cut-throat" flumes were designed and these were manufactured by RID at the Lam Nam Oon shops. The Construction Division had these installed before the onset of the Dry Season in December, 1981.

Messrs. Zola and Bell assisted Charoon Photsoonthorn of RID's O&M Division to organize five Water User Groups of farmer-irrigators in the area during October-November, 1981. The entire team worked with these Groups during December in physically digging and clearing the eroded tertiary and quaternary canals of Units I and II.

As Mr. Bell outlines in his attached study paper, detailed water measurement observations began on December 28, 1981 and ended on April 30, 1982. Thus, the water inputs and some drainage were measured in Units I and II for a period of 124 days. The day-by-day observations were made by Berger-employed Thai staff under the direction of Mr. Bell.

Mr. Zola assisted by his Berger-employed Thai associate Mr. Dusit Chantharyhun, began economic input and returns studies at Units I and II on December 15, 1981. These continued until harvesting and sale of all crops from the area in mid-June, 1982. The detailed results of this study are presented in the attached paper by Mr. Zola.

Locally assigned RID-employed Zonemen and Department of Agriculture Extension tambol (sub-district) extension agents assisted in some aspects of the field work. The Puyaiban's (Village headmen) of the two principal villages involved, Ban Khok Loh and Ban Phan, were very helpful during the various organizational stages.

Transportation for day-by-day conduct of the study was provided by the Berger advisory team.

IV. Findings:

The area planted in Units I and II during the 1981/82 Dry Season was very small. It amounted only to 10.8% of the area of the two Units.

Thus, observations of this range of limited experience can only offer tentative perspectives. Both Mr. Bell and Mr. Zola, in their studies, note certain problems and offer some recommendations for the future.

However, it is possible to assert the following with some confidence:

1. Unless the source of main water supply to the Units is properly managed nothing can be done, reliably, within the Units.

   RID management of the Right Main Canal during the 1981/82 Dry Season resulted in very erratic flow levels. Graph 2 with the accompanying daily chart of flows in Mr. Bell's paper clearly shows the erratic pattern.

   As Mr. Bell points out in his paper this erratic pattern proved to very disruptive of planned schedules particularly in Unit II - where rotation was to be done.

2. Unit I, which is the simplest in design of the three Units, performed much better from the standpoint of water use efficiency than did Unit II.

   Unit I, which had almost double the area under crop as compared to Unit II, used 20% less water.

   This may be a significant difference resulting from the design characteristics of Unit I. It will require further detailed observation during the 1982/83 Dry Season.

3. Unit II, though it was less efficient in water use than Unit I, produced crop yields that were about 20% higher than in Unit I.

   Could it be that the increased volume of water used by that Unit was an important factor?

   Mr. Zola, in his paper, attributes the difference to a number of other factors including: higher rates of fertilizer application in Unit II, more intensive use of labor in that Unit, an overall cash investment that was 31% higher than in Unit I, a larger quantity of seed used per rai in Unit II, and earlier training of Unit II farmers at the Ban Fang Daeng Training Center.

4. Cultivating farmer-irrigators located at all points inside Units I and II did not experience any difficulties in obtaining an adequate volume of water for their fields.

   However, as Mr. Bell observes, there was insufficient total farmer-irrigator demand on the systems so that it is not possible to assert that the design adequately provided water to all who might need it.

5. Similarly, the Gated Proportional Division Boxes could not be adequately tested because the demand for water by area was too low.

6. Drainage in both Units could not be measured because the outlet for the area's main drain is not adequately cleared. It also appears that some additional drainage improvement must be done within Units I and II.

   Early resolution of this problem is needed. Otherwise, planned attention to observing the Perched Water Table and the Ground Water Table in the two Units during 1982/83 cannot be successfully accomplished.

7. Unit III, which contains the densest network of ditch/dykes, access roads, and drainage needs to be compared with the other two Units during the 1982/83 Dry Season.

8. Neither of the Units showed the considerable loss in crop yield experienced at the land levelled areas during their first year of operation at Lam Nam Oon.

   This is not unexpected since the Lam Nam Oon model does not disturb the thin topsoils where it is installed.

9. Both Units produced less yields of groundnut than has been achieved in other areas of the Lam Nam Oon project in recent years.

   As Mr. Zola observes, averages yields for this crop now total 197.7 Kilos/rai at Lam Nam Oon. In Pilot Area 2, the average yield was 169.1 Kilos/rai.

   The difference may be attributed, in part, to the fact that this was the first year that the farmer-irrigators of Pilot Area 2 had ever farmed in the Dry Season.

10. Labor shortages for the Lam Nam Oon area, as predicted by Dr. George Hill in his Technical Note Number No. 2 of September, 1980 did not materialize at Pilot Area 2.

    In fact, as observed by Mr. Zola, the farmer-irrigators - particularly in Unit II tended to utilize too much labor.

11. The quality of groundnut produced at Pilot Area 2 was high, with a nut/shell ratio of significantly higher proportions than that prevailing in other areas.

    Mr. Zola surmises that this may be attributable to the market training given to the farmer's of the two Units.

STUDY I

Irrigation Water Measurements - Units I and II, Pilot Area 2

By: William Bell

I. Irrigation Water Inputs.

Estimates of water delivered to each Unit was made by measuring the flow from the Constant Head Orifice (CHO) serving the Unit. Each Unit is served by only one CHO. A "cut-throat" flume was installed in the lined canal section between the CHO and the first division box. Daily measurements of the water level in each flume was recorded, manually, by staff employed by the Berger Advisory Team. From these measurements and known characteristics of the flume the flow in liters/sec was calculated. In most cases the measurements were made late in the morning each day. This gave time for the flow to become stable and representative of the daily flow. These measurements give only an estimate at the daily flow as the level in the flume will vary somewhat with time. The CHO's were operated only during the day with opening and closing times varying; but a 10 hour day was about average. (Automatic level recorders would provide a much more accurate estimate of water deliveries).

Water was first made available on 12 December 1981 to PA2. The first water measurements on a systematic basis began on 28 December. During the intervening period ditches were cleaned, some minor construction finished, and farmers prepared to plant. Measurements ended on 30 April 1982 as water delivery in the Right Main Canal was closed for the season. Thus water was measured over a 124 day period (28 December - 30 April). Tables 1 and 2 show the estimated daily flows to each unit during the season. There were days when water did not flow into the units. There were two reasons for this, 1) the CHO was closed due to water not wanted or needed; 2) not enough water in the Right Main Canal. The tables show these as "(CLS)" and "(RMC)" respectively.

Table 3 shows the number of days each month that water was delivered or not, and the percentage of each. Unit I received water for 69% of time and Unit II 65%. Water was not available in the Right Main Canal for 19% of the time. Graph 1 shows the plot of daily flow for each unit during the season, and time without water in the RMC. Unit I shows a somewhat more continuous flow than Unit II. This reflects the way control of water was implemented for each. This is discussed later. During times of flow Unit II has, on average, a higher rate of flow, though the

Table 1

DAILY FLOW IN L/SEC FOR PILOT AREA 2 FOR DRY SEASON 1981-1982

UNIT I

DEC 1981

	76.8	70.8	(CLS)	53.7		

JAN 1982

					70.8	(RMC)
RMC)	(RMC)	120.1	91.3	123.8	61.1	102.6
54.1	83.0	76.8	65.0	67.9	55.7	79.9
70.8	95.8	109.5	34.6	59.5	(CLS)	(CLS)
CLS)	92.6	83.0	79.9	79.9	102.6	95.6
78.6						

FEB 1982

	89.3	46.4	79.9	50.4	39.2	46.4
CLS)	(CLS)	(CLS)	(RMC)	(RMC)	(RMC)	(RMC)
RMC)	(RMC)	(RMC)	28.3	43.9	65.0	46.4
56.7	86.1	15.5	39.2	(RMC)	(RMC)	(RMC)
RMC)						

MAR 1982

	(RMC)	(RMC)	(RMC)	(RMC)	(RMC)	92.6
(RMC)	(RMC)	(RMC)	(RMC)	18.8	173.4	70.8
102.6	51.5	48.9	48.9	175.1	150.5	106.0
51.5	70.8	76.8	26.3	26.3	67.9	24.3
18.8	22.4	(CLS)	22.4			

APR 1982

				24.3	30.3	113.0
86.1	34.6	30.3	(CLS)	(CLS)	(CLS)	(CLS)
(CLS)	(CLS)	(CLS)	41.5	51.5	56.7	34.6
24.3	46.4	48.9	36.9	34.6	39.2	36.9
83.0	46.4	39.2	76.8	46.4	79.9	

Table 2

UNIT II

DEC 1981

	158.5	143.5	123.8	146.6		

JAN 1982

					135.0	(RMC)
(RMC)	(RMC)	150.5	116.5	166.7	(CLS)	(CLS)
(CLS)	170.9	170.9	173.4	(CLS)	(CLS)	137.3
148.2	146.6	177:6	146.6	(CLS)	(CLS)	(CLS)
(CLS)	154.5	146.6	138.8	(CLS)	(CLS)	(CLS)
(CLS)						

FEB 1982

	121.6	158.5	146.6	(CLS)	(CLS)	(CLS)
(CLS)	(CLS)	(CLS)	(RMC)	(RMC)	(RMC)	(RMC)
(RMC)	(RMC)	(RMC)	7.1	36.9	34.6	32.5
39.2	162.6	59.5	102.6	(RMC)	(RMC)	(RMC)
(RMC)						

MAR 1982

	(RMC)	(RMC)	(RMC)	(RMC)	(RMC)	135.0
(RMC)	(RMC)	(RMC)	(RMC)	67.9	183.6	162.6
154.5	162.6	135.0	131.2	135.0	11.0	6.0
4.9	3.9	179.3	187.9	13.9	13.9	12.4
6.0	4.9	3.0	3.0			

APR 1982

				4.9	4.9	3.9
4.9	7.1	6.0	4.9	(CLS)	4.9	4.9
30.3	34.6	51.5	123.8	116.5	120.1	98.2
92.6	113.0	120.1	150.5	242.7	3.9	3.0
4.9	3.0	3.9	4.9	39.2	106.0	

total number of days is less. Overall the flows were erratic throughout the season. Assuming about a 10 hour day for the CHO being open the total quantity of water delivered to each unit was 200,143 m^3 for Unit I and 247,528 m^3 for Unit II.

Pilot Area 2 was designed to deliver water continuously as long as allocated water is about 100% of requirements. At some point less than this rotation would be necessary. For example, the quaternary units within a tertiary unit could be rotated, or tertiary units could themselves be rotated. At the beginning of the 1981/82 Season a schedule for Units I & II was made that basically rotated by quaternary units on a weekly basis. Most units were to receive water for one day with some larger units two days, and delivery based on 24 hours. Since the farmers did not want water at night and only a small number were irrigating this plan was altered. The altered plan was for Unit I to receive water more or less on a continuous basis with the Chak[5] leader and Zoneman[6] to rotate within the chak as needed. Unit II would operate on a 3 day on/4 day off sequence. As Graph 1 shows, this was followed to some extent. Until about the first week of February, Unit 2 was doing reasonably well. After this, the shut-downs of the RMC interrupted the sequence and it was not resumed. Unit I followed the continuous pattern except it too was interrupted by lack of flow in the RMC. Toward the end of March and mid April rainfall also interrupted irrigation schedules. Thus, overall, the daily flows were erratic.

The rotation of the quaternaries in Unit I was mostly supervised by the Chak Leader and the procedure was followed in a satisfactory way. This procedure does require more supervision and with more area under crop it may become cumbersome as a routine way to irrigate. Of course with a limited supply of water some rotation would be necessary. It would be better, in the future, to use the system as designed, with continuous flow to the system. This does not mean each farmer irrigates continuously. However, with only a small percentage of the area cropped and interruptions in the RMC this may not be feasible.

5/ Chak Leader is the farmer-irrigator elected by the other farmer-irrigators in a chak (area served by a CHO or a tertiary-quaternary canal) to act as leader of all within the chak area.

6/ Zoneman-Royal Irrigation Department employee responsible for 5,000 irrigated rai.

Table 3

Daily water delivery to Units I & II

	UNIT I (Days)			UNIT II (Days)		
	Open	Closed	RMC*	Open	Closed	RMC*
December	3	1	0	4	0	0
January	25	3	3	15	13	3
February	14	3	11	11	6	11
March	21	1	9	22	0	9
April	23	7	0	29	1	0
Total	86	15	23	81	20	23
% of each	69	12	19	65	16	19

* Indicates water in RMC not available

Graph 1

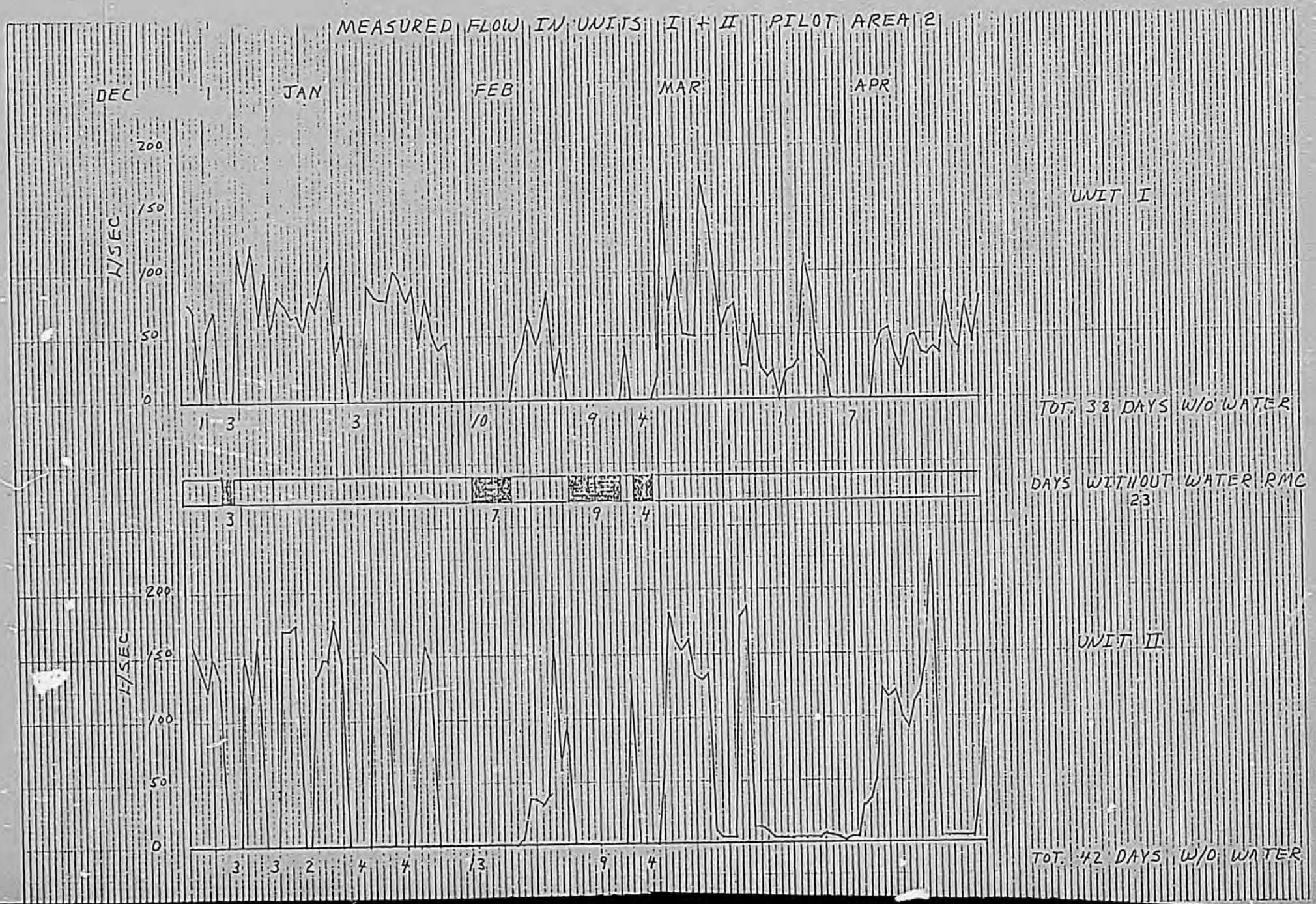

MEASURED FLOW IN UNITS I + II PILOT AREA 2
DEC
JAN
FEB
MAR
APR
L/SEC
200
150
100
50
0
UNIT I
1 3 3 10 9 4 1 7
TOT. 38 DAYS W/O WATER
3 7 9 4
DAYS WITHOUT WATER RMC
23
UNIT II
3 3 2 4 4 13 9 4
TOT. 42 DAYS W/O WATER

Table 4 lists by tertiary and quaternary Unit the number of rai irrigated during the season. Figure 1 shows the location, within Units I & II, of plots that planted crops. The solid areas are approximately to scale. Unit I had 84.25 rai and Unit II 49.25 rai.

In order to obtain perspective about the amount of the water delivered to each unit compared to estimated crop water requirements the analysis below was made. It should be noted that the assumptions made are, of necessity, rough. No attempt was made to get the kind of data needed to arrive at a complete water balance for PA2. The figures are in the "ballpark" and provide a feel for what is happening. As mentioned above the total quantity of water delivered to Units I & II was 200,143 m^3 for Unit 1 and 247,528 m^3 for Unit II respectively. Dividing this by the area cropped gives an application of 1,480 mm/rai and 3,141 mm/rai for Units I & II. Assuming an effective rainfall of about 125 mm and 500 mm requirement for groundnuts during the dry season this leaves about 375 mm to be supplied by irrigation. Thus the gross efficiencies for Units I & II are 25% and 12% respectively. Table 5, summarizes this analysis. A study by Bos, etc. et. al. of irrigation efficiencies of projects in many parts of the world gives a range of 20-30% for similar conditions. Unit I falls within this range, however Unit II is quite below. It is not clear what may have happened in Unit II to cause this low figure. Several reasons for low efficiency have been cited, these include:

1. Intermittant irrigation in the system is less efficient due to losses in dry ditches each time water flows through.

2. The small percent of area cropped that must be served by essentially the entire system. Thus canal losses are attributed to a small area.

3. Since this is the first time these farmers irrigated in the dry season with upland crops it is inevitable that they over-irrigate as this is common even among experienced farmers.

4. Fallow areas surrounding an irrigated area decreases efficiency. Low flow rates per served area decrease efficiency.

One or more of these as well as other factors may have contributed to the low efficiency in PA2 during the 1981/82 Dry Season.

Table 4

AREA & LOCATION OF

CROPPED AREA PA-2

(UNITS I & II)

UNIT I

T 1.1	38.50	T.1.2	45.75	S. TOT	84.25
-T 1.1	11.50	-QC 1	10.75		
-QC2.1	13.75	-QC 4.1	25.00		
-QC2.2	5.25	-QC 4.2	10.00		
-QC 31	4.50				
-QC3.2	3.50				

UNIT II

T 1.0	33.75	T. 1.1	15.50	S. TOT	49.25
-QC 2	4.00	-QC 1	10.50		
-QC 3	1.50	-QC 7.1	2.00		
-QC 4.2	4.00	-QC 7.2	3.00		
-QC 5	15.50				
-QC 6.1	3.75				
-QC 6.2	5.00				
				Total	133.50

Total Area Unit I	545.71	% in crop	15.4
" " Unit II	692.96	"	7.1
Average for Unit I & II			10.8%

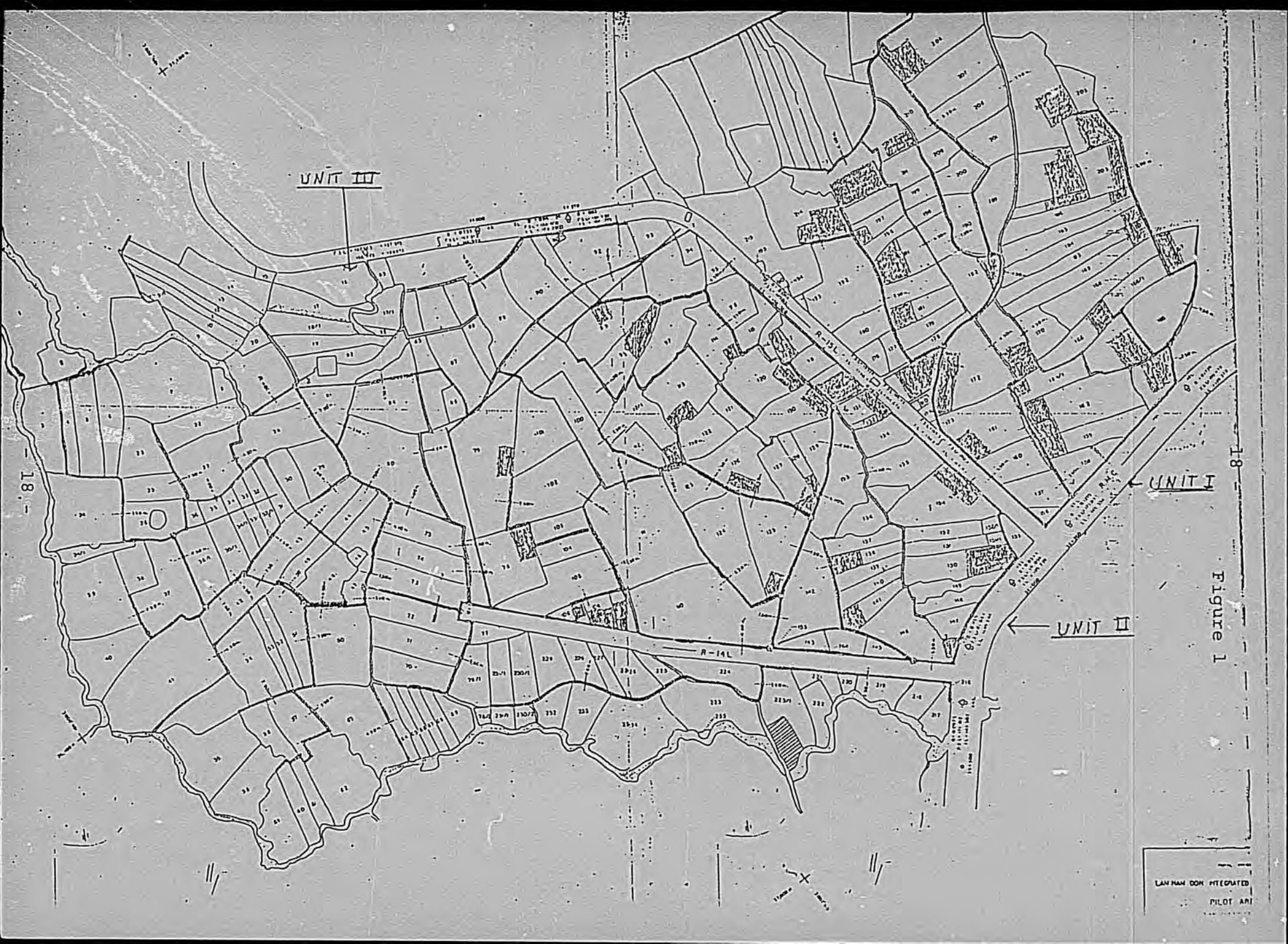

UNIT III
UNIT I
UNIT II
R-15L
R-14L
LAN NAM DON INTEGRATED
PILOT AR

Figure 1

Table 5

Estimate of Water Use Efficiency

	Unit I		Unit II	
Area Cropped	84.25	rai	49.25	rai
Total water delivered	200,143	m^3	247,528	m^3
Water applied/rai	1,480	mm	3,141	mm
Assumed requirement	500	mm	500	mm
Effective Rainfall	125	mm	125	mm
Required irrigation	375	mm	375	mm
Gross efficiency	25	%	12	%

Combined Efficiency 18%

Due to the small percentage of area planted (10.8% for both Units) and the scattered nature of this planting two important aspects of the operational research could not be assessed. The traditional problem of "headender" vs "tailender" did not show up. The largest number of rai planted in a quaternary unit was 25 for QC 4.1 in Unit I. Total area served by QC 4.1 is 151 rai thus only 17% of the area was planted. With this small area there was not enough demand on the system for this problem to occur. The proportional division boxes were designed to distribute required amounts of water to different units in proportion to the area served. For the reasons stated above it was not possible to assess wheather the division boxes would function as designed.

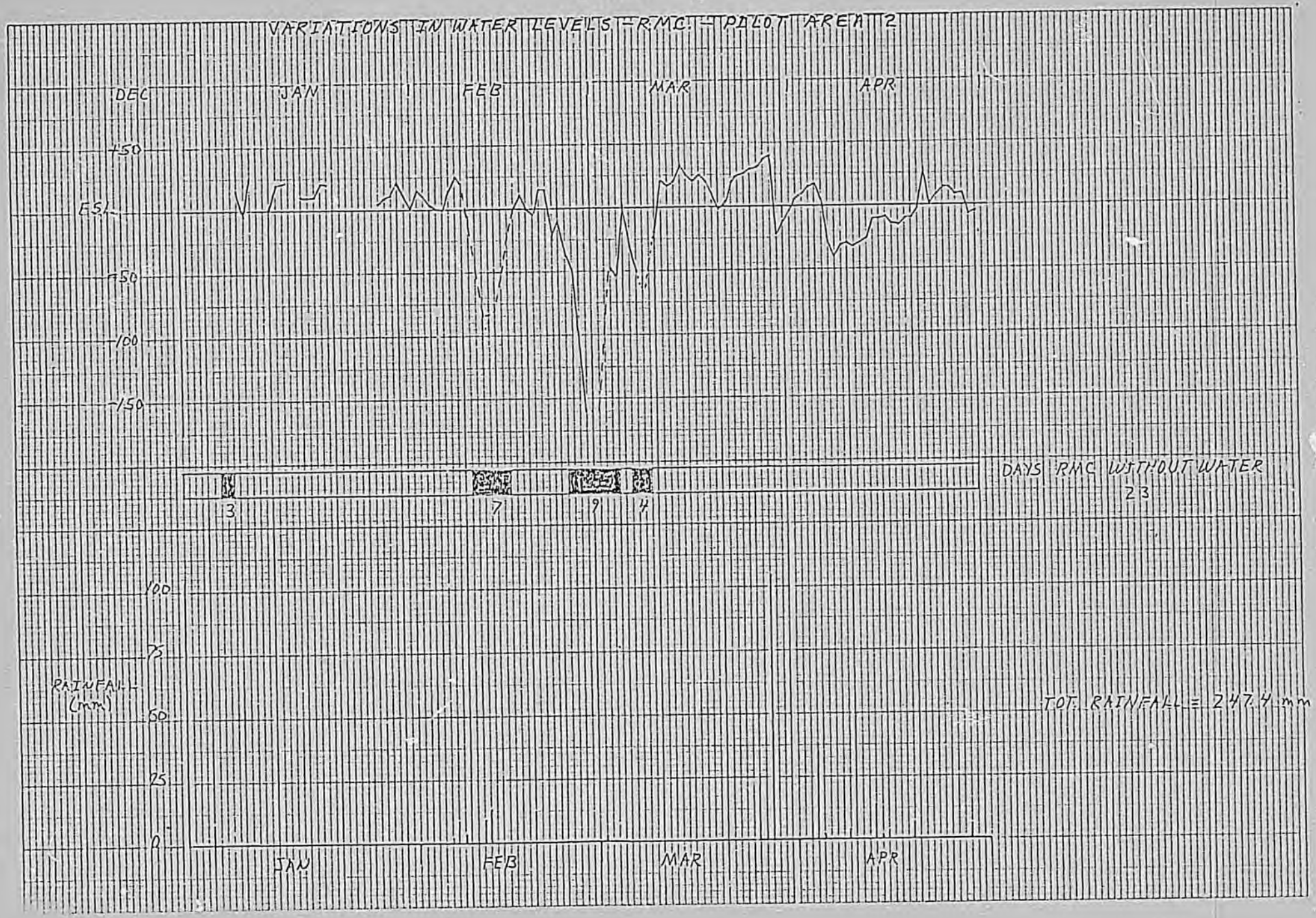
Graph 2 shows the variations in the water level of the Right Main Canal at the CHO serving Unit 2, it also shows rainfall. There were four periods when water was either measured or observed to be too low for delivery out of the CHO. This totaled 23 days or 19% of the time. The periods of time closed were attributed to holidays, obstructions in the canal regulator, and shut-down due to rain. The variations may be due to several other reasons. The main one is lack of overall management of the system, especially the main canals. The amount of water delivered out of a CHO depends an the water level in the canal. If it is too low than the required amount cannot be delivered. There were times during the season when water was needed but not available. This could have affected yields to some extent. With only about 11% of the area planted and water short, the result in future when large areas are planted will be drastic without better water management to assure a reliable water supply.

2. Drainage Measurements

Measurement of drainage flow began in Unit I on 10 February with the installation of a flume on Drain Q.D.1. Until about this time no runoff to the drain at this point was observed. Measurements continued until about March 25-26 when runoff from a heavy rainfall washed out the flume. During the period of measurement the average flow recorded was 150 l/sec. Assuming a flow of about 10 hours per day the total quantity would be about 130,000 m^3. This can only be a rough estimate of the total runoff. A major problem encountered was that the main drain had not been cleaned out and ponding occured in the adjacent low areas which could not be measured. As with measuring the irrigation flow, readings were taken once daily.

As mentioned above Unit II was less efficient than Unit I. In this regard it is of interest to note one occasion where irrigation inflow can be related to drainage outflow. On 6 March an irrigation inflow at Unit II of 135 l/sec was recorded, there being no other irrigation for several days before or after this day. The drainage outflow on 7 March was recorded at 106 l/sec. This is a reasonable lag time

GRAPH 2



20 Squares to the Inch

for drainage to occur and indicates that nearly all the inflow was runoff.

Drainage out of the main drain serving Unit I was not observed. Reasons contributing to this were: several non-cropped areas were inundated, there was accumulation in drains that could not runout, and one or two lower areas ponded with accumulated runoff.

3. Some observed problems in PA2

Pilot Area 2 was newly constructed and first put to use this dry season of 1981/82. This was first in two ways; 1) first use after construction (and of a design not used before), and 2) first use by farmers of any systematic irrigation for dry season cropping. Thus it was inevitable that some problems should arise. The following are some of the more prominent ones:

3.1 There were some missing farm outlets and some not located in the best place, several field crossings were needed, and some roads needed widening.

3.2 Some ditches were constructed not quite at the proper grade.

3.3 Due to erosion during the rainy season most all ditches needed to be cleaned before using.

3.4 As may well be the case in other ditch-dyke areas developed without extensive land leveling, there are some high areas that cannot be served from the irrigation ditches.

3.5 There were several ownerships where drains crossed the property isolating some portion from irrigation access.

3.6 Some ownerships not served directly from quaternary canals needed a small channel across (or alongside) other farmers to receive water, and sometimes another outlet. In cases known this was solved satisfactorily.

3.7 Some farmers had doubts about the flow of water from the outlet serving all parts of their farm. In some instances it would not serve a small area, but in most cases a survey revealed that water would flow if a small ditch was constructed by the farmer to convey it where needed. This was especially the case where a tertiary canal ran beside where they wanted to irrigate.

3.8 There were cases where farmers opened or closed gates illegally; but, overall, this did not seem to be excessive. With much larger cropped areas where demands on the system are greater it might become a problem.

3.9 It was also noted that "fishermen" would sometimes open the CHO's at night.

3.10 This being a new system there was some lack of knowledge by all as to the best way to operate it.

4. Suggestions and recommendations

4.1 It is suggested that water measurements both for irrigation and drainage continue for several more dry seasons. This should be done at least until one or two seasons have operated at somewhere near full capacity. Only then can the system be fully checked against design characteristics.

4.2 A continuous method of measuring flows should be used to better estimate water use. (Specifically, the use of the automatic level recorders as previously recommended).

4.3 It is imperative that ditches be cleaned by the farmers prior to the irrigation season to allow for design flows.

4.4 Continuous follow-up by O&M with the chak groups in operation of the system. As noted, Unit II was only half as efficient in water use as Unit I. This may be due, in part, to lack of knowledge on the part of the chak group in how best to operate the system.

4.5 The outlet for the drain serving Units II & III should be improved to allow full drainage and prevent the ponding as observed this season.

4.6 There are places within Units I and II where additional drains should be constructed to allow better drainage.

4.7 A system of observation wells in needed in PA2 to monitor the ground water levels.

4.8 A management program for controlling the water levels in the RMC should be established and followed to prevent the wide variations in water levels that now occur.

4.9 Same tests and measurements should be made to estimate the losses in the unlined ditches and in at least one cropped farm to estimate field losses.

4.10 As noted, there is a tendency for farmers to over-irrigate, there should be some training (formal or

informal) to help them in understanding when and how much water to apply.

4.11 Unit III of PA2 should be included as part of future operations research work.

4.12 As larger portions of PA2 are cropped operation at the system should shift to a continuous flow in the distribution system.

4.13 Establish a rain gauge near PA2 to provide a more accurate record of rainfall.

STUDY 2

Agro-Economic Data Analysis - Units I and II, Pilot Area 2

By: Anthony M. Zola

1. Introduction

The collection of agro-economic data in Pilot Area 2 during the 1981/82 dry season was one component of operations research scheduled for implementation in that land development area. Data collection generally followed that outlined in Project Planning Note No. 1, as drafted and revised.

Farmers living along tertiary and quaternary canals in the pilot area were selected for observation during July and August, 1981. Selection was based upon each farmer's location in Units I and II only in relation to water delivery. As planned, there was to be an emphasis on gathering data from headenders and tailenders. The thirty-three selected farmers were surveyed and interviewed to collect baseline data. They were contacted a second time in September to determine dry season cropping plans. At the time of second contact, problems with water delivery were reviewed and necessary adjustments in the delivery system made.

Training of all farmers in Pilot Area 2 in water management began in October, 1981. Special day-long training sessions in the use of the newly installed water delivery system were conducted by RID operations and maintenance staff. Training in groundnut and corn cultivation was handled by the tambon agriculture extension agent. Finally, in late October, five water user groups were organized encompassing all farmer-irrigators in the three units of Pilot Area 2. In the organizational meeting, the RID staff conducted training in system operations and maintenance through the mechanism of the water user group. The water user groups received formal training in irrigated agriculture production and water management at the Ban Fang Daeng training center in February and April, 1982.

The planting of dry season crops in Pilot Area 2 began during the last two weeks of December, 1981, and was completed by the end of January, 1982. It was during this time as well, that the LBII research assistant, Mr. Dusit Chantharyhun began data collection from the thirty-three pre-selected farmers in Units I and II. Initial contacts revealed that only eighteen of the thirty-three farmers had decided to cultivate dry season crops. Eleven of the eighteen had planted groundnuts, with five of the eleven planting other crops as well, including sweet corn and pumpkins.

A survey conducted in mid-April, 1982 in Pilot Area 2 showed that forty-five farmers in the three units were cultivating 104.50 rai of groundnuts. The second principle crop was sweet corn, with 41.75 rai being cultivated. Other crops being cultivated included:

Crop	No. of Farmers	Area (rai) Unit I & Unit II
Groundnuts	45	104.5
Sweet corn	36	41.75
Watermelons	4	2.25
Pumpkins	2	1.25
Vegetables	15	12.75
Other	23	15.50
Total	62	178.00

These figures indicate that about 10.8% of the 2,400 rai in the three units of Pilot Area 2 was cultivated during the 1981/82 dry season. The area planted in groundnuts was 58.7% of the cultivated area.

Although data was collected on all crops planted in the area, the emphasis of this analysis is on groundnut production. The data was collected by the LBII research assistant during each stage of production. Thus, data on land preparation was collected at the time farmers were preparing their fields for planting. Data collection was carried out during the period between December, 1981, and May, 1982.

As mentioned above, thirty-three farmers had been selected based upon plot location along canals, from which cropping data was to be collected. In that only eighteen of the thirty-three farmers actually planted a dry season crop and only eleven planted groundnuts, figures from other cultivators have been included in the data base. The method of data collection was the same as that used for the pre-selected farmers. The purpose of expanding the data base was to increase the sample size, making the analysis more reflective of local conditions. The attached map, Annex B shows plot locations (but not the scale of planting per plot) from which data on groundnuts and other crops was collected. Thus, data from sixteen of the forty-five farmers (35% sample size) who planted groundnuts is the basis of this analysis. Data analyzed in this study was collected from farmers cultivating dry season crops in Units I and II.

The Tainan 9 variety of groundnut was planted by all farmers sampled. This variety is recommended by the Department of Agriculture and the Department of Agriculture Extension as that best suited to Lam Nam Oon conditions. In addition, this variety is preferred by groundnut traders as it is easily marketed due to its high oil content. It has been observed that all farmers cultivating groundnuts in Pilot Area 2 during the 1981/82 dry season planted the Tainan 9 variety.

2. Analysis

The average area planted in groundnuts in Pilot Area 2 was 2.1 rai. The average area in Unit I was 2.52 rai and in Unit II, 1.41 rai. Sample data was collected from 10 farmers planting 25.25 rai of groundnuts in Unit I, and 6 farmers planting 8.5 rai in Unit II.

Thirteen of the sixteen farmers sampled (81%) received credit in kind from the BAAC for agricultural inputs. The principle input for which credit was obtained was chemical fertilizer. The average cost, of inputs was 548 Baht per rai, with a range of 270.50 to 1,134.50 Baht per rai. Fertilizer averaged 246.25 Baht per rai, with Unit II recording nearly twice the investment in fertilizer per rai when compared to Unit I. The high fertilizer input in Unit II is reflected in the 20% higher yields obtained in Unit II. Farmers in Unit II may have felt the need to add significant quantities of fertilizer due to the poor quality of the Roi-et soils in their area. In Unit I, a portion of the area has Korat series soils which are more fertile, requiring less fertilizer. However, yields were significantly different.

Disease and pest problems were minimal. Only one farmer reported applying insecticide to his groundnuts.

As can be observed in the summary table (Table 1) expenditures for seed were higher than for other inputs. Tainan 9 seed was purchased through the tambon agriculture extension agent and from nearby villages for 8 to 11 Baht per kilogram. The expenditure for seed in Unit II was higher, reflecting the fact that 35.27 kilograms of seed were planted per rai, versus 27.28 kilograms per rai in Unit I a 22.6% difference. This higher planting rate may have influenced the yields obtained in Unit II.

The correlation between fertilizer application and yield was reasonably high (Table 8.2). The correlation coefficient was r=.768 for Pilot Area 2. The correlation coefficient for Unit I was r=.403, significantly lower than that for Unit II, r=.751, and for the whole pilot area. The difference may be due to the significant difference in quantities of fertilizer applied in each area: 27 kilograms per rai in Unit I and 58 kilograms per rai in Unit II.

Family labor use was recorded during each stage of production. The average figure was 32.4 mandays per rai. When compared to manday figures from other sources, this figure is somewhat high. Von Fleckenstein[7/] in his record-keeping survey of sample farmers in Kalasin and Roi-et, found that labor inputs for groundnuts ranged from 14.5 mandays to 47 mandays per rai. The Pilot Area 2 figure is within this range. However, a 1973 IBRD study of tank irrigation in Northeast Thailand[8/] used a figure of 15.7 mandays per rai for groundnut production. And, a study from Indonesia[9/] quotes figures of approximately 17 mandays per rai.

Von Fleckenstein's 14.5 mandays per rai figure may be too low however, as it is from the Kalasin Research and Training Center at Huay Sithon. The labor mandays from his sample farms was 47 mandays per rai.

For the purposes of this analysis, the Pilot Area 2 figure is used to calculate the net return per manday of family labor. This result is compared in the summary evaluation with a figure calculated using the IBRD figure.

None of the farmers in Pilot Area 2 employed hired labor during the growing season.

The cost of family labor was established at 25 Baht per manday, a figure used by the Department of Agriculture and the Office of Agricultural Economics in their calculations relating to Lam Nam Oon. At this rate, family labor input cost was 810 Baht per rai.

The labor input costs in Unit II were 46% higher than those in Unit I. This more intensive labor input may have been a factor in the production of higher yields in Unit II.

The other cash cost was the interest payment loans from the BAAC which amounted to 21.75 Baht per rai, a relatively insignificant amount.

7/ Von Fleckenstein, Fritz, Works and Days: An intensive record-keepting study of irrigated and rainfed farms in Northeast Thailand, FArm Management and Production Economics, Technical Report (Draft) UNDP/FAO, THA/74/015, April, 1980.

8/ IBRD, Pioneer Project for Tank Irrigation in Northeast Thailand, Volume 1, September, 1983: pp. 55-59.

9/ Kediri-Nganjuk Groundwater Irrigation Project, Indonesia, 1975.

The total cash input costs for groundnut production in Pilot Area 2, averaged 548 Baht per rai. The figure for Unit I was 211.25 Baht less than that for Unit II. That is, farmers in Unit II invested about 31% more in groundnut production than the farmers in Unit I.

Average yields (Table 8) were somewhat below those obtained in other areas of the Lam Nam Oon irrigated area. Figures obtained from the Sakon Nakhon Upland Crops Experiment Station indicate that the average yield for the Lam Nam Oon area for the 1981/82 dry seaons was 197.7 kilograms per rai. The highest yields were obtained in the L-1L canal system, in the area of Ban Oom Mao: 264.3 kilograms per rai. The average yield for Pilot Area 2 was 169.1 kilograms per rai. There was a significant 40 kilogram per rai difference in yield between Unit I and Unit II. Yields in Unit II were 20.6% higher than those obtained in Unit I.

This significant difference in yields may be due to several factors: 1) higher rate of fertilizer application in Unit II; 2) more intensive use of labor in Unit II; 3) overall cash investment in Unit II was 31% higher than in Unit I; 4) seed costs per rai in Unit II were greater than those in Unit I, indicating that a larger quantity of seed per rai was used by Unit II producers: 5) in that farmers in Unit II were given training in water use management and groundnut production at the Ban Fang Daeng training center early on in the dry season (February), they could have applied their newly learned technology to their groundnut plots. Farmers in Unit I were given training at Ban Fang Daeng later on in the season (April), when it was too late to apply the technology to make any difference in groundnut yields.

Because of the small sample size and the scattered location of the plots, no correlation can be made between location on a canal and yield figures. For the same reasons, no correlation can be made between soil series and yield figures (Table 8.1).

Inexperience in the cultivation of groundnuts may be the principle reason for the below average yields obtained in Pilot Area 2. High yields, especially in Unit II, are possible, with yields of 230 and 280 kilograms per rai obtained by two farmers. There is a need to increase use of fertilizer, as a high correlation coefficient can be expected.

All groundnut producers in Pilot Area 2 were able to sell their crop at the Government guaranteed price of 7 Baht per kilogram. The principle buyer, a trader from Ubon, reported that the quality of the groundnuts from Pilot Area 2 was good. The produce he purchased needed no further drying. The nut/shell ratio was a high 65-70% nut/30-35% shell, by weight. This is significantly higher than the normally acceptable 60%/40% ratio, already considered good.

The marketing training at Ban Fang Daeng and intensive follow up by the S.A.T. agents could have been factors influencing the standard of groundnuts produced. During each farmer training session, quality control of groundnuts was emphasized. In addition, the matter of maintaining quality standards was included in S.A.T. training sessions and brought to their attention frequently. The importance of producing a good quality crop was made clear to the farmers.

Further, the late date of purchasing (early June) along with a delay in the early rains, provided sufficient opportunity for farmers to adequately dry their groundnuts. Only minimal amounts of refuse or foreign material was found mixed with the groundnuts. For the most part, stems had been removed from the peanut shell. Together, these factors resulted in a high quality nut from Pilot Area 2.

Gross returns per rai averaged 1,171.50 Baht, with a range of 816.67 Baht to 1,960 Baht. As expected, gross returns in Unit II averaged about 18.5% more than Unit I.

In column 23, net returns per rai excluding family labor are given. The average for Pilot Area 2 was 608.75 Baht per rai, with a median of 618.25 Baht per rai. The range was very wide, from 157.75 Baht to 1,040.50 Baht per rai.

In columns 25 and 26, net return per manday are shown. In columns 25 (A), net returns per manday are calculated using the figures for mandays of family labor use given in column 8. In columns 26 (B), net returns per manday are calculated on the basis of the standardized labor use figure of 15.7 mandays per rai, which was used in the 1973 IBRD report. It is clear that farmers received less than a reasonable return on their labor if the labor use figure from Pilot Area 2 is used. An increase in the efficiency of family labor management would significantly improve the chances of obtaining a higher returns per manday of labor.

Recommendations

Several recommendations can be made regarding groundnut production in Pilot Area 2 based upon this analysis:

1. Farmers need to be advised on how to more efficiently use family labor. Net return per manday of family labor could be increased significantly with the reduction of labor input.

2. The use of chemical fertilizer according to technical recommendations of the Department of Agriculture needs to be impressed upon the farmers. Farmers in Unit II applied fertilizer according to these recommendations with positive results.

3. Data on groundnut production should be collected from other areas of the Lam Nam Oon irrigated area. From a comparative analysis of such data, one would be able to determine the productivity level of Pilot Area 2 as compared to other areas.

4. It is necessary to increase sample sizes in order to prepare an analysis which will accurately reflect conditions in the area selected.

5. Groundnut yield figures from Pilot Area 2 are acceptable, yet below the average for Lam Nam Oon. With the introduction of advanced production technologies, improved water management, and close follow up by field personnel, Pilot Area 2 can obtain increased yields and develop its production potential.

Other Crops

Several other crops were cultivated in Pilot Area 2 during the 1981/82 dry season. These crops included:

sweet corn
cucumbers
pumpkins
cabbages
peppers (chilies)
watermelons

Only small areas of each of these crops were planted by a few farmers. From the data collected it is difficult to draw any conclusions.

Sweet corn was favored as a second crop following groundnuts.

Input costs and net income figures shown on the attached charts were calculated from the minimal data collected on these crops.

References

1. Von Fleckenstein, Fritz, Works and Days: An intensive record-keeping study of irrigated and rainfed farms in Northeast Thailand, Farm Management and Production Economics, Technical Report (Draft), UNDP/FAO, THA/74/015, April 1980.

2. IBRD, Pioneer Project for Tank Irrigation in Northeast Thailand, Volume 1, September, 1983.

3. Final Report of Kediri - Nganjuk Project, DPU, Jakarta, Indonesia. 1975.

4. Hughes, Anthony, Evaluation of dry season peanut programme Prasart Land Settlement 1979/80, April, 1980.

5. Dalton, James, Project Planning Note No. 1, Revised Draft, 9 September, 1981; and, First Draft, 17 June, 1981.

Dry Season Groundnut Cultivation

Pilot Area 2, Units 1 and 2

Lam Nam Oon, Sakhon Nakhorn

All figures are averages.

Sample Size	Crop Variety	Average Area Planted (rai)	Inputs			Labor use (mandays)						
			Item	Baht per rai	Total Baht	Activity	Per rai			Total		
							F.L.	H.L.	Cost (Baht)	F.L.	H.L.	Cost (Baht)
1	2	3	4	5	6	7	8	9	10	11	12	13
16	Groundnuts, Tainan 9	2.10	Seed	286.25	535.75	Land Preparation	21.85	-	546.50	32.5	-	812.50
			Fertilizer	246.25	346.25	and Planting		-	62.50	3.92	-	98
			Insecticide	(a)	(a)	Maintenance	2.49	-	201.50	13	-	325
			Equipment	12.75	29.50	Harvesting	8.06					
			Other	-	-							
			Total	548	913		32.4	-	810	49.5	-	1,237.50
				(Range = 270.50 to 1,134.50)								

Notes:

(a) = Only one farmer applied insecticide at a cost of 6 Baht per rai.

Interest (Baht		Total Cash Input (Baht)		Output					Net Return Excluding Family Labor (Baht)		Net Return per manday of Family Labor (Bah	
				Yield (kg.)		Sale Price (Baht/kg.)	Gross Return (Baht)					
Per rai	Total	Per rai	Total	Per rai	Total		Per rai	Total	Per rai	Total	A	B
14	15	16	17	18	19	20	21	22	23	24	25	26
21.75	18.75	560.75 (Range= 270.50 to 1,169.25 baht) Median Value= 505.50 baht Standard Deviation= 250 baht	931.75	169.1 (Range= 116.67 kg. to 280 kg.) Median Value= 163 kg. per rai Standard Deviation= 40.77 kg.	323.4	7	1,171.50 (Range= 816.67 to 1,960 baht) Median Value= 1,125 baht Standard Deviation= 283 baht	2,264	608.75 (Range= 157.75 to 1,040.50 baht) Median Value= 618.25 baht Standard Deviation= 210 baht	1,318.25	18.75	38

A.= Family labor use taken from column 8.

B = Standardized labor use of 15.7 mandays per rai (IBRD, Pioneer Project for Tank Irrigation in Northeas Thailand, Volume 1, September, 1973, p. 55-59).

Pilot Area 2

Dry Season Crop Production

1981/82

Number of Sample Farmers and Area Planted

Crops	Unit 1 Sample		Unit 2 Sample		Total of Samples in Pilot Area 2	
	No. of Farmers	Total Area (rai)	No. of Farmers	Total Area (rai)	No. of Farmers	Area (rai)
Groundnuts	10	25.25	6	8.5	16	33.75
Sweet corn	3	1.75	7	6.25	10	8
Cucumber	-	-	1	.5	1	.5
Pumpkin	-	-	1	1	1	1
Cabbage	-	-	1	.5	1	.5
Peppers	-	-	1	.5	1	.5
Watermelon	-	-	2	1.25	2	1.25
Total		27		18.50		45.50

Pilot Area 2

Dry Season Crop Production

1981/82

Table 3

Crops Planted by Individual Farmers: Unit 1

Unit 1	Crops Planted (rai)						
Pilot No.	Groundnuts	Sweet corn	Cucumber	Pumpkin	Cabbage	Peppers	Water-melon
161	1						
163	2						
181	3	.5					
184	1						
186		.75					
197	.75						
202	2	.5					
204	4						
212	1.5						
213	5						
214	5						
Total Unit 1	25.25	1.75					
No. of Plots = 11	10	3					

Pilot Area 2

Dry Season Crop Production

1981/82

Table 3.7

Crops Planted by Individual Farmers: Unit 2

Unit 2	Crops Planted (rai)						
Plot No.	Groundnuts	Sweet corn	Cucumber	Pumpkin	Cabbage	Peppers	Water-melon
78	.5	.5					
79		.25					.25
99	1						
113	3						
120	.5	.5					
127	1						
133		1.5	.5				
138		1.5					
141		1.5					
144						.5	
131	2.5			1			
147		.5			.5		1
Total Area Unit 2	8.5	6.25	.5	1	.5	.5	1.25
No. of Plots= 12	6	7	1	1	1	1	2
Total Area Unit 1	25.25	1.75					
No. of Plots= 11	10	1.3					
Total Sample Pilot Area 2	33.75	8	.5	1	.5	.5	1.25
No. of Plots= 23	16	10	1	1	1	1	2

Pilot Area 2

Dry Season Crop Production

1981/82

Table 4

Average Area Planted

Crop	Average Area Planted (Rai)		
	Unit 1	Unit 2	Total Pilot Area 2
Groundnuts	2.52	1.41	2.10
Sweet Corn	.58	.89	.8

Pilot Area 2

Dry Season Crop Production

1981/82

Table 5

Total Input Costs

Crop	Total Cash Input (Baht)					
	Unit 1		Unit 2		Pilot Area 2	
	Per rai	Total	Per rai	Total	Per rai	Total
Groundnuts	468.75	1,042	680	697.25	548	913
Sweet Corn	765	437	570	421.50	628.75	426.25
Cucumber	-	-	1,132.50	566.25	1,132.50	566.25
Pumpkin	-	-	174	174	174	174
Cabbage	-	-	1,199	599.50	1,199	599.50
Peppers	-	-	1,135	2,270	1,135	2,270
Watermelon	-	-	440	263.50	440	263.50

Pilot Area 2

Groundnut Production

Dry Season, 1981/82

Table 5.1

Average Input Costs

Average Input Costs

Item	Unit 1		Unit 2		Total Pilot Area	
	Baht per rai	Total Baht	Baht per rai	Total Baht	Baht per rai	Total Baht
d	264.25	622.75	323.25	391	286.25	535.75
tilizer	186	379	346.50	291.75	246.25	346.25
ecticide	6	18	-	-	6	18
ipment	14.50	38.25	10	15	12.75	29.50
c.	-	-	-	-	-	-
al	468.7	1,042	680	697.25	548	913
ge	312-706.50	300.50-1,689	270.50-1,134.50	511-1,074	270.50-1,134.50	300.50-1,689

Pilot Area 2

Groundnut Production

Dry Season, 1981/82

Table 6

Average Labor Use

Activity	Average Labor Use (mandays)					
	Per rai			Total		
	F.L.	H.L.	Cost (baht)	F.L.	H.L.	Cost (baht)
ınd 'eparation ıd Planting	21.85	-	546.50	32.50	-	812.50
intenance	2.49	-	62.50	3.92	-	98
rvesting	8.06	-	201.50	13	-	325
tal	32.4	-	810	49.40	-	1,235

Pilot Area 2

Groundnut Production

Dry Season, 1981/82

Table 7

Investment Costs - Groundnuts

Plot No.	Total Cash Input (Baht)		Labor Costs (Baht) (Family Labor)		Interest (Baht)	
	Per rai	Total	Per rai	Total	Per rai	Total
Unit 1						
181	471	1,413	602.50	1,809.50	5.80	17.40
163	312	624	425	850	8.70	17.40
161	706.50	706.50	650	650	17.40	17.40
214	338	1,689	285	1,425	3.48	17.40
184	566	566	800	800	17.40	17.40
197	400.75	300.50	982.50	737.50	-	-
213	319	1,595	545	2,725	3.48	17.40
212	609.50	865	865	1,300	11.59	17.40
204	341	1,363	380	1,525	-	-
202	623.25	1,296.50	567.50	1,137.50	17.40	34.80
Average	468.75	1,042	610.25	1,296	10.75	19.50
Unit 2						
131	430	1,074	620	1,550	6.96	17.40
120	1,024	511	2,075	1,037.50	34.80	17.40
78	1,134.50	567	1,900	950	34.80	17.40
113	270.50	811	500	1,500	-	-
127	681	681	762.50	762.50	17.40	17.40
99	540	540	1,000	1,000	17.40	17.40
Average	680	697.25	1,143	1,133.25	22.25	17.40
Pilot Area 2						
Average	548	913	810	1,235	15.00	18.75

Pilot Area 2

Groundnut Production

Dry Season, 1981/82

'able 8

Yields

Unit : kilograms.

Crop	Unit 1		Unit 2		Pilot Area 2	
	Per rai	Total	Per rai	Total	Per rai	Total
oundnuts	154.1	376	194.1	235.8	169.1	323.4

Pilot Area 2

Groundnut Production

Dry Season, 1981/82

Table 8.1

Yields related to soil type and plot location on canals

nit 1

Plot No.	Soil Series	Location: Canal No.	Location: Point	Area Planted (rai)	Yield per rai (kg.)	Legend
181	R	Q 2.1	M	3	123.33	Q = Quaternary Canal
214	K	Q 2.1	T	5	166	T = Tailender
197	K	Q 2.1	T	¾	160	M = Mid-canal plot
213	K	Q 2.1	T	5	140	H = Headender
184	R	Q 4.1	M	1	180	T.C. = Tertiary Canal
204	R	Q 4.1	T	4	132.5	R = Roi Et Soils
202	K	Q 4.1	T	2	160	K = Korat Soils
163	R	Q 4.2	H	2	140	
161	R	T.C.1.1	M	1	160	
212	K	Q 3.2	T	1½	180	
						No. of Samples
verages			T	3.04	156.41	6
			M	1.66	154.44	3
			H	2	140	1
nit 2						
120	K	Q 5	M	½	280	
99	K	Q 5	T	1	230	
131	R	Q 1	T	2½	168	
78	R	Q 6.1	T	½	180	
113	K	Q 7.2	T	3	116.67	
127	R	Q 4.2	H	1	180	
						No. of Samples
erages			T	1.75	176.16	4
			M	.50	280	1
			H	1.00	180	1

Pilot Area 2

Groundnut Production

Dry Season 1981/82

Correlation of Fertilizer to

Yields of Groundnut

Table 8.2

Plot No.	Yield per rai (kg.)	Fertilizer per rai (kg.)
Unit 1		
181	123.33	16.66
214	166	10
197	160	0
213	140	10
184	180	50
204	132.5	25
202	160	50
163	140	25
161	160	50
212	140	33.33
		Coefficient of Correlation for Unit 1: r = .403
Unit 2		
120	280	100
99	230	50
131	168	50
78	190	100
113	116.67	0
127	180	50
		Coefficient of Correlation for Unit 2: r = .751
		Coefficient of Correlation for Pilot Area 2: r = .758

Pilot Area 2
Groundnut Production
Dry Season, 1981/82

Table 9

Gross Returns

Unit 1

Pilot No.	Area Planted	Gross Return		
		Per rai	Total	
181	3	863.33	2,590	
163	2	980	1,960	
161	1	1,120	1,120	
214	5	1,162	5,810	
184	1	1,260	1,260	
197	¾	1,120	840	
213	5	980	4,900	
212	1½	1,260	1,890	
204	4	927.50	3,710	
202	2	1,120	2,240	
Average		1,079.25	2,632	
Unit 2				
131	2½	1,176	2,940	
120	½	1,960	980	
78	½	1,130	665	
113	3	816.67	2,450	
127	1	1,260	1,260	
99	1	1,610	1,610	
Average		1,325.50	1,650.75	
Pilot Area 2				
Average		1,171.50	2,264	

Pilot Area 2

Dry Season Crops Production
1981/82

Table 10

Average Net Income

(Figures exclude cost of family labor)

Crop	Unit 1 (฿)		Unit 2 (฿)		Pilot Area 2 (฿)	
	Income excluding labor		Income excluding labor		Income excluding labor	
	per rai	Total	per rai	Total	per rai	Total
Groundnuts	580.75	1,153	655.25	927	608.75	1,318.25
Sweet corn	185	90.50	137	116	151.50	108.25
Cucumber	-	-	1,648	804	1,648	804
Cabbage	-	-	475.50	224	475.50	224
Peppers	-	-	5,034	2,467	5,034	2,467
Watermelon	-	-	1,067.50	703.75	1,067.50	703.75

Pilot Area 2

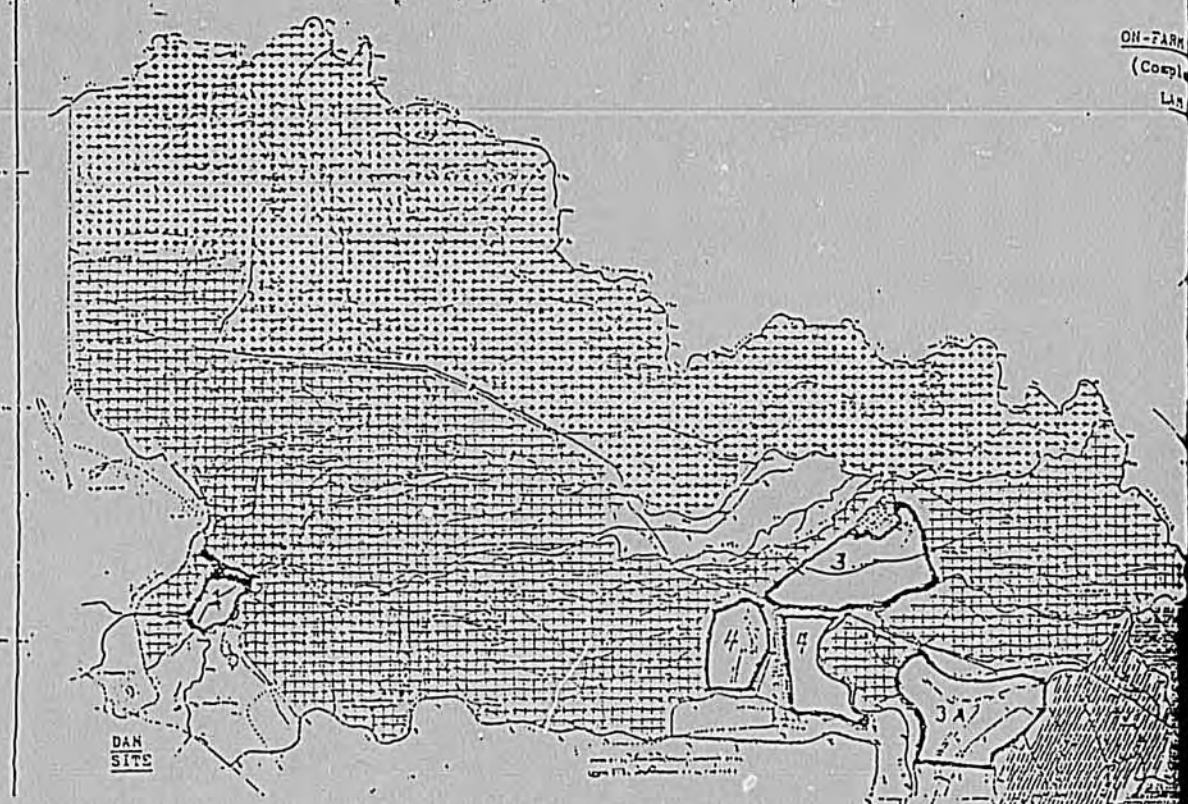
Groundnut Production

Dry Season, 1981/82

Table 10.1

Net Income (baht)

No.	Area	Excluding Family Labor	
		Per rai	Total
Unit 1			
181	3	365.50	1,138.50
163	2	644.25	1,303.50
161	1	390	390
214	5	769.50	4,052.50
184	1	667.50	667.50
197	¾	713.25	533.50
213	5	612.50	3,242.50
212	1½	624	992.50
204	4	556.50	2,317
202	2	464.25	893.75
Average	2.5	580.75	1,553
Unit 2			
131	2½	718	1,827.50
120	½	895.25	445.50
78	½	157.75	77.50
113	3	567.25	1,618
127	1	552.50	552.50
99	1	1,040.50	1,040.50
Average	1.4	655.25	927
Average P.A. 2	2.10	608.75	1,318.25



INTENSIVE - Land levelled, consolidated, rectangterised. Chanasutr

Completed:-

Area 1	1976	1,000 Rai
Area 3	1979/80	2,154 Rai
Area 3A	1981	2,650 Rai
		5,804 Rai, ready for use in Dry Season 1982/83.

Planned:

Area 4	1983	2,710 Rai
		8,514 Rai, planned total of land-levelled, rectanglerised, on-farm water delivery systems.

48

ANNEX A

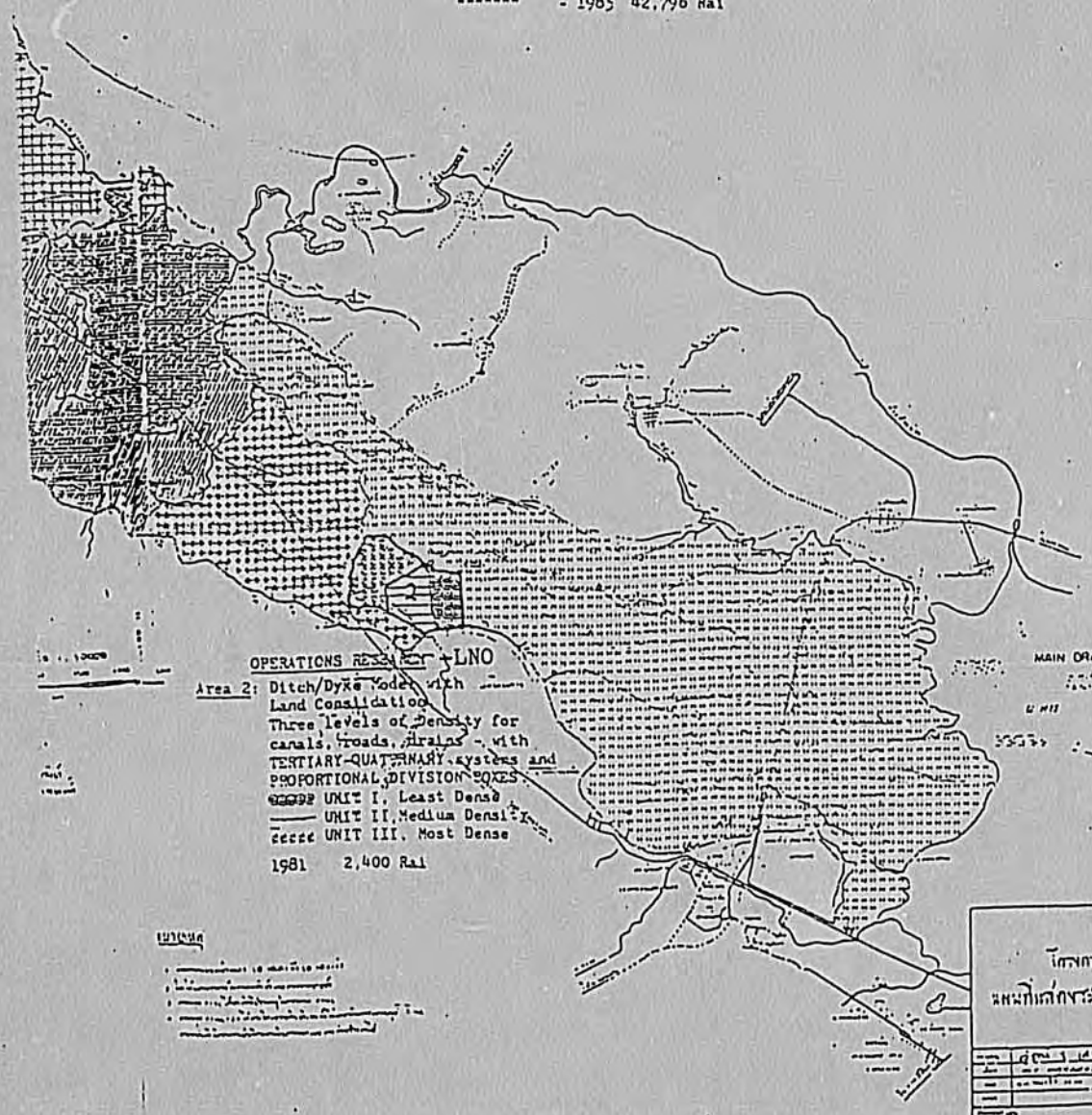
1976 to 1985
(B.E. 2519 to 2528)

CONSTRUCTION
of
ON-FARM WATER DELIVERY SYSTEMS
(Completed and projected)

LAI NAM OON

EXTENSIVE - Ditch/Dyke Model (Modified Nong Rai) with land c[illegible]dation, standard density roads, canals, and drains. No Quaternary system and no proportionall Division boxes.
Rotation by checking and sequencing.

////////	- 1982	8,504 Rai (Force Acciunt)
#######	- 1982	6,663 Rai (Contractor)
+++++++	- 1983	58,000 Rai
+++++++	- 1984	57,500 Rai
-------	- 1985	42,796 Rai



ANNEX B

Project Planning Note Number 1

(Revised Draft)

Title: Pilot Areas 2 and 3A - Tests and Training

Purpose: Learn how farmer's use and benefit from two systems of water delivery and train them in how to use the systems.

Method: Install measuring instruments and observation/training schedules on a planned basis (using the smallest number of staff possible) to:

1. Record Full Supply Level's (FSL's) in Tertiary and Quaternary Canals in Units I and II, Pilot Area 2, with particular attention to studying 'headenders' and 'tailenders'.

2. Record and observe Division Box operation within Unit II, Pilot Area 2, with particular attention to a Quaternary Canal.

3. Record the volume of water delivery, use, and loss (drainage and evapotranspiration) in Units I and II, Pilot Area 2.

4. Record Yields in Units I and II, Pilot Area 2 and along two selected Tertiary Canals in Pilot Area 3A (3,000 rai).

5. Observe FSL's in two selected Tertiary Canals within Pilot Area 3A (3,000 rai) with particular attention to "headenders" and "tailenders"

6. Train Zonemen and selected farmer's within Units I and II. Pilot Area 2 and on the two selected Tertiary Canals within Pilot Area 3A (3,000 rai) on how to best operate the systems.

7. Develop and test various ways of organizing the farmers' to use water within Units I and II, Pilot Area 2 and along the two selected Tertiary Canals, Pilot Area 3A (3,000 rai).

Location: As shown, in detail, on separate maps for each Pilot Area.

Schedule: See Work Plan of August 20, 1981. Immediate actions required as of September 9, 1981 are (1) Approve Equipment Procurement; (2) Order Equipment; (3) Build Prototype Cut-Throat Flume; (4) Request Assignment of Design and Survey staffs effective October 15;

(5) Order materials for additional Cut-Throat Flumes and prepare to construct in October.

Staff: (a) The responsible RID Zonemen; (b) Selected farmer's; (c) RID Survey Team; (d) RID Design Team; (e) Construction Shop Metal Workers; (f) Construction Crew; (g) Systems and On-Farm Irrigation Engineer (Consultant); (h) Training and Farmer Organization Specialist (Consultant); Agronomist (Consultant) - if employed in time for 1981 Dry Season.

Equipment: Constructed by RID:

Cut-Throat Flumes, metal, permanent	-	8
" " " " , portable	-	1
Total		9

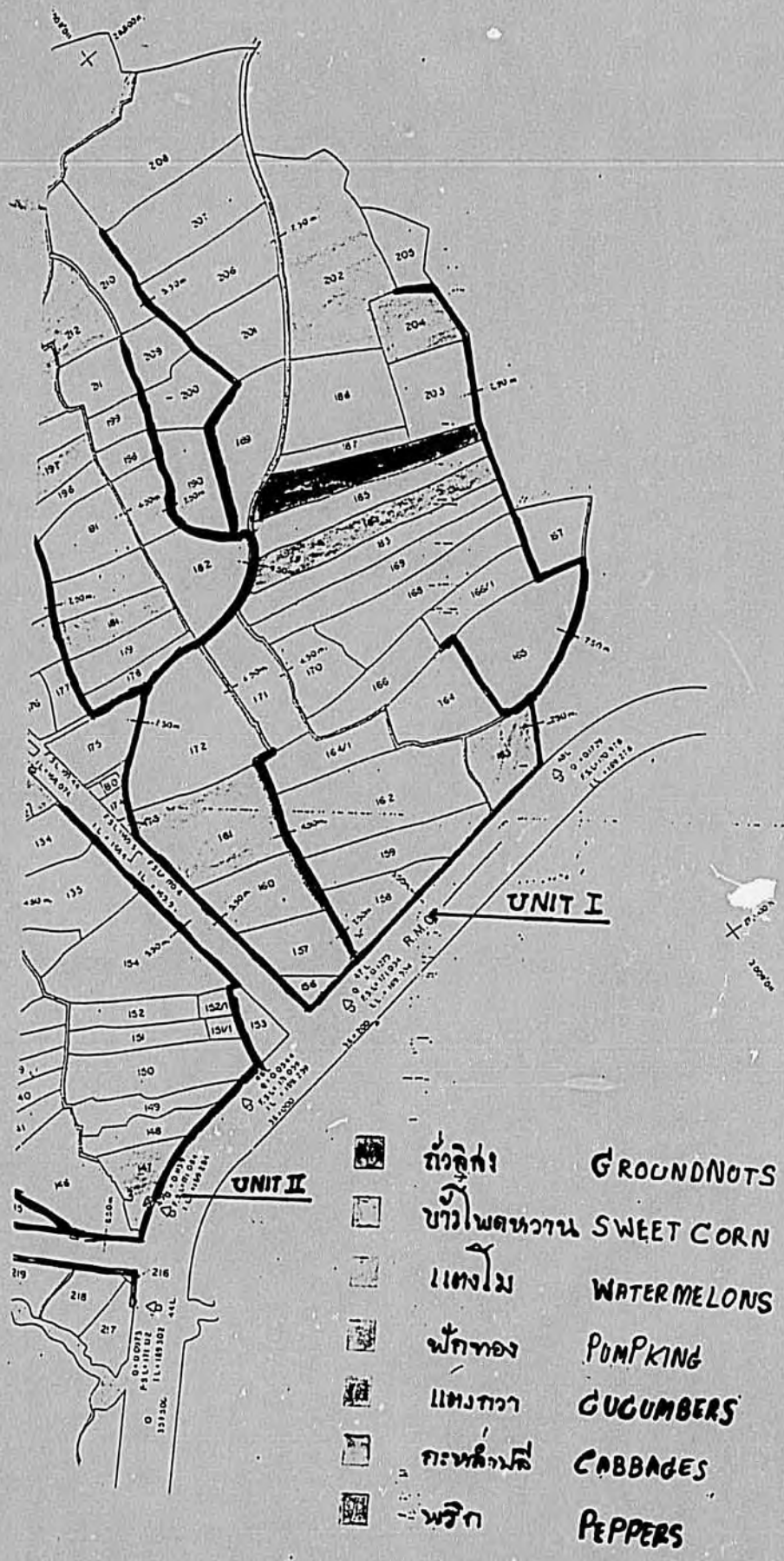
Estimated Cost: Baht 2,000/Flume Baht 18,000

Special Equipment for measuring/recording to be connected to Apple III Computer in Berger consultant offices, and thereby reduce staff time spent on recording data:

1	Solar Radiation and Temperature Recorder (Datapod DP2620) with attachments	$ 1,185
1	Tipping Bucket and Rain Gage recorder (DP)	1,180
6	Still Wells and DP 1712'S Recorders	6,800
1	217D Data Storage Reader	1,490
1	UVSLLE Data Storage Eraser	115
15	DSM1000 Data Storage Modules	825
12	C10 10-foot cables	144
1	SC254 Connector Cable	45
1	Computer Interface	470
	Total	$10,764

UNIT III

R-14L
R-15L



ROYAL IRRIGATION DEPARTMENT

LAM NAM OON INTEGRATED RURAL DEVELOPMENT PROJECT

PILOT AREA No. 2

LAM NAM OON IRRIGATION PROJECT

DETAIL OF SYSTEM LAY OUT

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