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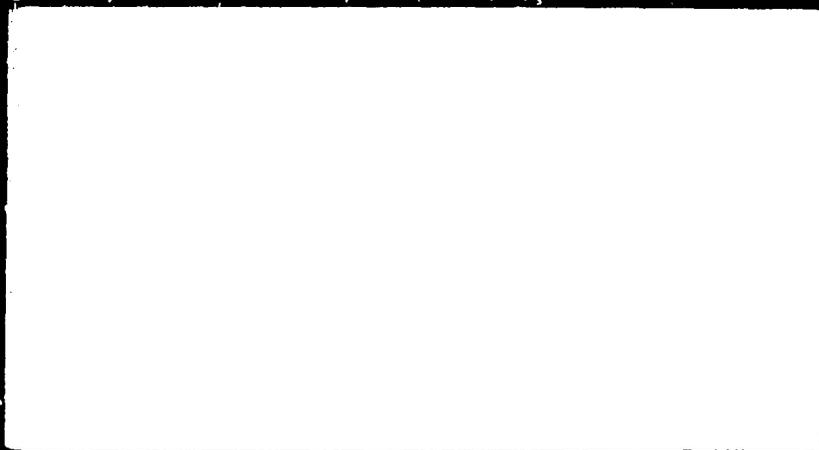
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9. ABSTRACT

Investigates the characteristics of dry season farming and farmers in Northeast Thailand; this paper suggests hypotheses for explaining extremely low use of dry season irrigation, based on a case study of a selected area considered to be typical of the region. The Lam Pao irrigation project, located in Kalasin province, was chosen for study. Results and statistical data presented in this paper are derived both from secondary sources and from an on-farm survey of farmers in the Lam Pao area. Each farmer was interviewed two times, once to complete a schedule of questions relating to wet season farming, and a second time to obtain data on dry season irrigated cropping. Findings indicate that failure to use irrigation water during the dry season results from a complex interaction of forces. Some are largely social or cultural and some are principally of economic origin. The institutional framework supporting dry season irrigation has not developed to a degree comparable to that achieved in either the Northern or Central regions of the Kingdom. The rights and responsibilities of the major participants--peasant farmers on the one hand and government officials on the other--have not been adequately defined. Administrative problems have also been encountered in the availability and timeliness of government supplied and/or subsidized inputs, such as seed, fertilizer, water and pesticides. If a farmer can once be induced to try dry season cropping, he is likely to expand the irrigated area which he crops in subsequent years. Recommends increased investment of money and scientific man years in applied research designed to develop economically feasible technological packages for dry season cropping.

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**IRRIGATED DRY SEASON CROP PRODUCTION
IN NORTHEAST THAILAND: A CASE STUDY**

**Russell H. Brannon, Charles T. Alton
and Joe T. Davis**

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Irrigated Dry Season Crop Production in Northeast Thailand:

A Case Study

In an effort both to increase overall agricultural production and to improve per capita incomes and levels of living of the rural populace of the Northeast, the Government of Thailand has made substantial investments in irrigation facilities in the region. Historically, Northeastern farmers have relied primarily on wet season glutinous rice production for their livelihood, producing basically for home consumption and marketing the surplus in good years. In more recent years the production of maize, kenaf, cassava, and other upland crops has assumed increasing importance. Irrigation has been used principally to supplement rainfall during the rainy season, with dry season irrigated cropping being of very limited importance even in those areas where adequate infrastructure exists to permit such activity. It has been estimated that during the 1972 dry season, only 1.6 percent of the irrigable land in the Northeast was actually used to grow crops.^{1/} The advent of the new higher yielding, fertilizer responsive varieties of non-photoperiod sensitive rice, and the demonstrated potential for multiple cropping, have provided added impetus for

^{1/} Government of Thailand, Royal Irrigation Department, Water Resources Development in Thailand Completed to the End of 1972 and Under Construction in 1973, Bangkok, Thailand: Ministry of Agriculture and Cooperatives, June, 1973. Similar findings of very limited dry season irrigation use in the Central Plain are reported in Leslie Eugene Small "An Economic Evaluation of Water Control in the Northern Region of the Greater Chao Phya Project of Thailand", unpublished Ph.D. dissertation, Cornell University, 1972.

increased governmental concern over the limited area devoted to dry season irrigated cropping.

It is the objective of this paper to investigate the characteristics of dry season farming and farmers, and to suggest hypotheses for explaining extremely low utilization of dry season irrigation in Northeast Thailand, based on a case study of a selected area which is considered to be fairly typical of the region.

Characteristics of Northeast Thailand

The fifteen provinces which comprise the region of Thailand known as the Northeast contain approximately one-third of the Kingdom's population and a third of the land area. Although precise data are not available, population growth in the region has been estimated at nearly 3.0 percent per annum over the past 25 years, and despite significant investment in family planning activities is not expected to drop below 2.5 percent in the near future. An estimated 90 percent of the economically active population of the region is engaged in agricultural production at some time during the year. Rural employment shows substantial seasonal fluctuation; in 1974, in the Northeast, the dry season labor force was only 67 percent as large as that reported in the wet season.^{2/}

Historically, the Northeast has been the most backward of the four regions of the Kingdom. In terms of average cash income per rural household in 1969, the Northeast ranked last, at only \$255, compared to a

^{2/} Unpublished 1974 survey data of the National Statistical Office.

Kingdom-wide average of \$404. and an average of \$650 in the Central Region. Although the Northeast contained about 30 percent of the Kingdom's households, it accounted for 48 percent of the "poverty" households--defined as those earning cash incomes of less than eighty-six dollars.^{3/} Other indicators of levels of well-being also place the Northeast at the bottom (e.g. social services, health and nutrition levels, literacy rates, etc.). It has only been in the past 20 years that the national government in Bangkok, and various international development assistance organizations, have begun to express much interest in the problems of this region, and to increase public investment in agricultural infrastructure.

Geographically, the Northeast lies roughly on the Khorat Plateau, a saucer shaped basin which ranges in altitude from 500 to 1,000 feet above sea level. The Phetchabun mountain range and the Dong Phraya Yen range to the west, and the Sankamphaeng range in the southwest separate this region from the northern and central regions of the Kingdom. It is separated from Laos to the east and north by the Mekhong river, and from Cambodia to the south by the Dong Rek scarps. Most of the region is drained by the Mun river and its tributary, the Chi, which flow into the Mekhong. Several other small tributaries in the northern part of the region drain directly into the Mekhong.

^{3/} Derived from data contained in Oey Meesook, "Income Distribution in Thailand", Thammasat University Discussion Paper No. 50, p. 11. Original data collected by the National Statistical Office and reported in the Socio-Economic Survey 1968/69.

During the rainy season, (May-November) the rivers quickly fill and inundate the low flat valleys of the flood plain. During this period, most of the land is devoted to rainfed padi rice production on small banded plots. During the dry season, much of the padi area lies fallow. There are, however, isolated areas of dry season irrigated cropping, as well as substantial upland areas devoted to drought tolerant crops including cassava and kenaf. The dominant soil types of the region, the red-yellow podzolics and the low-humic gley soils, are typically only of low to moderate fertility, and some areas have serious salinity problems. Average yields for many crops trail those of other regions.^{4/}

The Study Area

The Lam Pao irrigation project, located in Kalasin province, was chosen as the area for a detailed case study of dry season irrigation use. This project, with water impounded behind a 7.9 kilometer earth-filled dam completed in 1968, is fairly representative of such projects in Northeast Thailand in terms of population, soil type, cropping pattern, rainfall pattern, supporting infrastructure, and problems of water utilization. Average size of holding of agricultural

^{4/}The 1971-75 average yields for selected important crops in the Northeast were: rice, 1.4 metric tons per hectare; groundnuts, 1.1 tons; cassava, 12.4 tons; soybeans, 0.84 tons. Comparable Kingdom-wide yields were: rice, 1.7 tons; groundnuts, 1.2 tons; cassava, 14.5 tons; soybeans, 0.89 tons. For detailed information on crop production, yields, and areas devoted to various crops, see Russell H. Brannon, "Agricultural Sector Assessment: Thailand", USAID/Bangkok, January, 1978, pp. 51-63.

land in the Lam Pao area is approximately 2.8 hectares.^{5/} At the time of the study (1973/74), one main canal and a secondary system of laterals and sublaterals had been completed, which theoretically would permit the dry season irrigation of 16,000 hectares of land. During the 1973/74 dry season, however, only 246 hectares were actually cropped in this area.

Data Sources

Results and statistical data presented in this paper are derived both from secondary sources and from an on-farm survey of farmers in the Lam Pao area.^{6/} Major secondary data sources include the Royal Irrigation Department, the Department of Land Development, the Mekong Committee, the United States Agency for International Development Mission in Thailand, the Huey Sithon irrigated crops research station, and the Northeast Agricultural Center.

Primary data were collected at the Lam Pao site through interviewing a stratified random sample of 125 farmers who were growing crops during the 1974 dry season (out of a total population of dry season irrigation farmers of approximately 1,100). Each farmer was interviewed two times, once to complete a schedule of questions relating

^{5/} For additional detail on the Lam Pao area, see Ronald C.Y. Ng "The Demographic Pattern" and "The Land Holding Pattern", Lam Pao Land Use Report Series No. 1 and No. 2, School of Oriental and African Studies, London: University of London, 1974.

^{6/} See Charles T. Alton, "The Economics of Dry Season Irrigation in Northeast Thailand", unpublished Ph.D. dissertation, University of Kentucky, 1977

to wet season farming, and a second time to obtain data on dry season irrigated cropping. The population was divided into two strata:

1) those who had cropped in previous dry seasons and 2) those who were cropping for the first time during the current dry season.^{7/}

Initial pre-interview reconnaissance was conducted both in Lam Pao and in surrounding regions in order to identify issues to be addressed in the study and to refine questions to be covered in the interviews. Farmers, community leaders, and government officials were informally interviewed in the process of developing the schedules. These schedules were then pre-tested in a similar area outside of the sample area, and necessary revisions were made.

Actual interviewing was conducted by native speaking Thai interviewers familiar with the local dialect and the agriculture of the region. Interviews were conducted at the convenience of the farmers (with about a third of these taking place at night).

Findings

The failure to more fully utilize irrigation water during the dry season results from a complex interaction of forces, including those of a primarily organizational or administrative nature, some which are largely social or cultural, and some which are principally of economic origin. These will be discussed separately, even though this results

^{7/}The sample did not include farmers who were not growing any irrigated crops during the dry season; thus, findings can not legitimately be generalized to this group. However, knowledge of the area, field observations, and non-structured discussions with farmers suggest that the constraints encountered are very similar to those identified in the sample group.

in a somewhat artificial division given the mutual interdependencies. A summary of the reasons given for not cropping all available irrigable land is presented in table 1.

Organizational and administrative problems. The institutional framework supporting dry season irrigation in the Lam Pao project has not developed to a degree comparable to that achieved in either the Northern or Central regions of the Kingdom. Working rules regarding the rights and responsibilities of the major participants--i.e. peasant farmers on the one hand and government officials on the other--have not yet adequately evolved.^{8/} Illustrative of this point is the fact that the farmer's perception of the government's responsibilities in terms of construction, operation, and maintenance of the irrigation system varies widely from that of government officials' perception. Under provisions of the Ditches and Dikes Act of 1962, the Royal Irrigation Department (RID) is responsible for construction, operation, and maintenance of the primary and secondary distribution system (i.e. main canals and major secondary laterals), whereas the farmer is responsible for construction, operation, and maintenance of the tertiary distribution system (i.e. inter and intra-farm ditches). Two quasi-administrative

^{8/} Participants in a recent seminar on irrigation systems in Southeast Asia identified the need for greater farmer participation in nations throughout this region in irrigation operation and maintenance, noting the potential for reducing the administrative and logistic burdens of irrigation, facilitating improved day-to-day decision making on water distribution, and providing water users with greater incentives to use water carefully. See Rogelio C. Lazaro, Donald C. Taylor, and Thomas H. Wickham, Irrigation Systems in Southeast Asia: Policy and Management Issues, New York: Agricultural Development Council, May, 1977, p. 8.

Table 1. Reasons Given for Not Cropping All Available Irrigable Land

<u>Reasons</u>	<u>Individual Respondents</u>	<u>Percent of Respondents</u>
Insufficient family labor	43	36
Insufficient water	32	27
Plot too far away and lack of security	18	15
Experimenting to determine desirability	9	8
Insufficient funds for inputs	8	7
Inadequate seed	4	3
Anticipated marketing difficulties	3	3
Insufficient hired labor	1	1
Busy with another job	1	1

Source: Survey of farmers in Lam Pao irrigation project.

Note: Only first priority responses are included. Percentages do not total to 100 due to rounding.

positions, the head of the farm turn-out (HFTO) and the zone man, have been established to facilitate the use of irrigation water.^{9/}

Although 90 percent of the farmers interviewed (113 out of 125) indicated that they were responsible, as individual members of the water users' association,^{10/} for constructing the inter and intrafarm ditches, only 20 percent (25 out of 125) felt that they were individually responsible for decisions to repair and maintain them. The majority (70 percent) of those interviewed considered it the responsibility of the HFTO to make decisions regarding maintenance. In terms of operation, two-thirds of the respondents considered the HFTO to be responsible for opening the farm turnout water gate, while nearly a third viewed this as an individual farmer decision. This inadequate definition and communication of roles and responsibilities among parties creates uncertainty and holds the potential for substantial conflict.

^{9/}The HFTO is an elected representative chosen from among those farmers who own land along any particular main ditch, and is to function as an intermediary between the government and farmers. The government relies upon the HFTO to achieve agreement among farmers as to operation and maintenance of the particular ditch for which he is responsible. However, there are no explicit rules or procedures for conflict resolution or compensation for those who may consider themselves inequitably treated. The zone man, a Royal Irrigation Department official, has the responsibility for allocating water among farmers within the particular segment or zone of the irrigation system to which he is assigned. He is the point of closest local contact between farmers and the Royal Irrigation Department.

^{10/}All farmers in the irrigation project are automatically members of the water users' association, for which there is a nominal fee of only \$1 per year. There is no charge imposed for the water which is provided. In the future, as water becomes an increasingly valuable resource, it will probably be necessary to develop and institute a system of water fees, and this is likely to create serious conflicts as farmers are required to pay for what heretofore has been free.

Administrative problems have also been encountered in the availability and timeliness of government supplied and/or subsidized inputs. Given the seasonal nature of agriculture, it is crucial that inputs such as seed, fertilizer, water, and pesticides be made available when and where needed, and a few days delay may be disastrous in terms of production. Furthermore, in order to grow rice in the dry season, it is essential that a variety which is not sensitive to day length be planted, and the seeds of these varieties are available only from government rice stations. When Lam Pao farmers made their plans for the 1974 dry season planting and communicated them to local officials, orders were placed for 14 tons of improved seed for use in two amphoes^{11/} within the study area. However, only six tons were delivered in time for planting (December) with another three tons to be made available in April. Thus, less than half of the area on which farmers desired and planned to plant dry season irrigated rice could be planted during the 1974 dry season. Table 2 summarizes reasons given by farmers for deviating from their dry season planting intentions.

The government also has a program for distributing free insecticides to rice producers, but regulations provide that they can be issued only after the presence of a serious insect infestation has been determined and v rified. Thus, these insecticides are not available for use as a

^{11/}

An amphoe is a small political sub-division similar to a county.

Table 2. Reasons Given for Difference Between Dry Season Planting Intentions and Actual Plantings

Reasons for Cropping Less Land than Originally Planned

<u>Reasons</u>	<u>Individual Respondents</u>	<u>Percent of Respondents</u>
Insufficient labor available	18	27
Insufficient seed available	15	23
Concern over water availability	10	15
Unfavorable weather	8	12
Concern over credit availability	3	5
Concern over market availability	2	3
High price of inputs	2	3
Other	8	12

Reasons for Cropping More Land than Originally Planned

<u>Reasons</u>	<u>Freq.</u>	<u>%</u>
Higher price for crop	15	71
More water available	1	5
More hired labor available	1	5
Could get more land	1	5
Other	1	5
No reason given	2	10

Source: Survey of farmers in Lam Pao irrigation project.

Note: Only first priority responses are included. Percentages may not total to 100 due to rounding.

preventive treatment, and distribution and administrative bottlenecks obviate early treatment on first detection. Serious rice stem borer infestation in the 1974 dry season caused great concern to farmers and damage to their crops, yet farmers were reluctant to purchase insecticides on the open market as long as there existed the possibility of receiving them free of charge from the government. Thus, given the operational inefficiencies, the existence of the government input subsidy program tended to be a negative factor in the adoption process. Problems of timely fertilizer availability under the government supported fertilizer distribution program also dampened enthusiasm for the expansion of dry season irrigated cropping, and a similar situation reportedly existed with respect to government credit provided through the Bank of Agriculture and Cooperatives (BAAC). Although reportedly not difficult to obtain, timeliness of receipt of requested funds was a problem.^{12/}

Inadequate communication between government officials and farmers regarding timing of delivery of water in the main canals has also introduced a substantial amount of additional uncertainty into an already risky production process. Forty-three percent of the farmers interviewed indicated that they had encountered problems obtaining water at the times that they needed to irrigate their crops, and it

^{12/} For example, in 1974, a local official in the Lam Pao area reported having made application for loan funds prior to the dry season for distribution to farmers planning irrigated cropping, but the requested funds were not made available until nearly time for harvest of the dry season crops. Legislation passed in 1975 required commercial banks to channel five percent of deposits into agricultural loans, increasing to 7 percent in 1976, 9 percent in 1977, and 11 percent in 1978. However, lending institutions have thus far been largely ineffective in reaching limited resource farmers.

was further noted that often they were not given advance warning of water shutoffs for repair of primary and secondary distribution structures.

The achievement of potential yield increases inherent in improved varieties is highly dependent upon the interaction of water, commercial fertilizer, and pest control, as well as upon improved cultural practices. This constitutes a much more complex technological package than does the traditional method of wet season padi rice production, and under the best of conditions is viewed as much more risky undertaking.^{13/} Any additional risk and uncertainty introduced as a result of administrative inefficiencies has a very discouraging effect on potential adopters.

Socio-Cultural influences. Although the study revealed a strong and positive influence of technical assistance on the extent of individual participation in dry season irrigation (those who had received technical assistance were cropping an average of 26 percent more land than those who had not), there was evidence of considerable reluctance on the part of small farmers to seek the assistance of government officials. The person most frequently approached for assistance, and the one with whom the closest relationship existed,

^{13/} Risk is greater for a number of reasons. Lack of familiarity with the new practices of dry season cropping is one. Another is that a higher percentage of purchased inputs must be used in the production process, thus requiring a cash outlay. Cropping during the dry season when the surrounding area is uncropped also greatly increases crop vulnerability to bird damage and theft.

was the HFTO. Farmers were reluctant to approach directly RID officials, and the higher up the chain of command in the RID, the more hesitant was the farmer to seek assistance from that individual. Paradoxically, in the perception of farmers the success rate in solving problems increased with the rank of the official approached. Thus, the culturally imposed respect for authority appears to have restrained direct requests for assistance even when serious problems were encountered.

It was anticipated, a priori, that formal educational levels might represent a significant positive factor in terms of adoption of the new dry season production practices. Rogers has cited 274 studies, from various countries, 74 percent of which tend to support such a hypothesis.^{14/} In the present study, however, no evidence was found to support this hypothesis. This may be due to the relatively low variation in educational achievement among those sampled. Average educational level for the area was only about four years, with a coefficient of variation of only 30 percent.

On the other hand, it was found that farmers with more years of dry season farming experience tended to plant a larger area during the survey year than those with fewer years of experience. This suggests

^{14/} Everett M. Rogers and F. Floyd Shoemaker, Communication of Innovation: A Cross-Cultural Approach, New York: Free Press, 1971.

that if a farmer can once be induced to try dry season cropping, he is likely to expand the irrigated area which he crops in subsequent years.^{15/}

In the course of the survey, a number of farmers indicated that lack of security for their fields during the dry season was a problem because few other crops were being grown and the likelihood of theft of growing crops was significantly increased.^{16/} This tended to restrict cropped areas to the proximity of the owner's house or to houses of relatives or friends. More isolated areas, even if fertile and readily irrigable, were not regarded as a good risk. One cultural response to this problem has been the development of a system of rent-free "borrowing" of land from other farmers who do not plan to crop during a given dry season. Although other considerations such as soil fertility and proximity to roads and to the main irrigation ditch were mentioned, among the thirty-three farmers who borrowed land, the most frequent reason given (Table 3) was that their own land was too far from their house (forty-two percent of the respondents).^{17/}

^{15/} This conclusion would be negated, however, if large numbers of farmers elect to try dry season irrigation one time, and subsequently abandon the practice. The data do not permit analysis of this possibility, but general knowledge of the area suggests that it is not a major problem. Additional research on this aspect of the adoption process is needed.

^{16/} The authors had first hand personal experience with the problems of theft of standing crops during on-farm trials with peanut growers in the Northeast, while assisting the Ministry of Agriculture and Cooperatives at the Northeast Agricultural Center, Tha Phra, Khon Kaen. This occurred even during the rainy season when cropped areas were extensive.

^{17/} This distance, of course, affects not only the security of the crops, but also imposes an economic cost in terms of time and effort required to reach the plot with tools, draft animals, and other production inputs.

Table 3. Reasons Given for Borrowing of Land in the Dry Season

<u>Reasons</u>	<u>Individual Respondents</u>	<u>Percent of Respondents</u>
Own land too far from house	14	42
No water for own land	8	24
RID encouraged it	2	6
Others had better land	2	6
Other	7	21

Source: Survey of farmers in Lam Pao Irrigation project.

Note: Only first priority responses are included. Percentages do not total to 100 due to rounding.

The study failed to identify any constraints to dry season cropping imposed by tradition, fear of disapproval of peers or elders, religious attitudes, or similar factors.^{18/}

Economic factors. It was hypothesized that profitability of dry season irrigated cropping would have a positive effect on the amount of land cropped during the dry season. Results of this study indicated that during the 1974 survey year, net cash returns to dry season irrigated cropping averaged \$57.25 per farm (\$394 per hectare) among the farmers sampled. Given the 1974 average total annual net cash return per farm from all farming activities in the region of only \$125,^{19/} irrigated cropping appears quite economically attractive. However, the coefficient of variation for the sample was 98 percent, (C.V. in variable costs was 97 percent and in gross returns 94 percent), suggesting that there is a fairly high order of risk involved.

This study also revealed a positive relationship between the amount of fixed assets ^{20/} which a farmer held, and the amount of irrigated land which was cropped during the dry season. One might view the level of assets as a proxy measure of the ability to assume risk.

^{18/} Another study of irrigation in the Northeast also failed to identify any significant cultural constraints of this nature. See Howard K. Kaufman, "Socio-Economic Factors in Farmer Response to Irrigation in Northeast Thailand", Bangkok: USAID, September, 1971.

^{19/} This figure is based upon 1972 Ministry of Agriculture and Cooperatives, Division of Agricultural Economics data, and increased by the inflation rate for 1972-74.

^{20/} Fixed assets were defined to include only the value of land owned and the value of farm equipment, and this appears to be a reasonable procedure given the very low level of other asset holdings among Northeast farmers.

Given the fact that these are predominantly small, traditional farmers who grow wet season crops primarily for home consumption, and market only the surplus, this interpretation appears logical, particularly in view of the additional requirement for purchased inputs in dry season cropping.^{21/}

A related, but somewhat different, finding was that working capital (as measured by the amount of cash received from sale of crops from the preceding wet season) also positively affects the area cropped during the dry season. This relationship probably stems partially from the requirement for purchased inputs, but also represents another form of cushion against risk; i.e., its effect is likely inter-related with that of the stock of fixed assets.

In view of the above, it appears somewhat paradoxical that farmers did not view credit availability as an important constraint. At the time of the survey, only 10 of the 125 farmers were receiving any form of credit during the dry season, and these farmers were using the funds for livestock purchases rather than crop production. Only eight of the 125 respondents indicated that they would not have had sufficient funds to purchase needed inputs even if they had elected to crop all of their irrigable land during the 1974 dry season. Thus, it appears that under current conditions credit is not imposing an important constraint to expansion of dry season cropping in the area.

^{21/} In contrast to the auto-consumption orientation of wet season production, irrigated cropping is much more market oriented. Sixty-eight percent of the dry season crops were marketed, and only thirty-two percent consumed in the household. However, there are also other logically possible explanations for the relationship, e.g. asset accumulation may be a function of farming skill, and since irrigated farming requires greater skill, this is the group which engages in it.

At current levels of production, the survey did not find that the availability of markets for dry season crops was limiting. Farmers, however, indicated that if production were to expand substantially there likely would be problems in maintaining a profitable price level, particularly for fresh vegetables and similar produce. This problem has, of course, been encountered in many development projects in various countries around the world.

The functioning of the commercial input market appeared to be fairly efficient. This observation is substantiated by other studies in the area.^{22/} The previously discussed problems with government administered input supply programs were, however, of concern to farmers in the area. Other than for dry season rice production for which they relied fairly heavily on government supported inputs, the majority (115 of 125) of the farmers depended upon the commercial market for inputs.

It is often argued that during the dry season rural labor is in such excess supply in Northeast Thailand that its marginal productivity is essentially zero. The marginal productivity of labor in the sample was, however, found to be positive (6.6 baht per day).^{23/} It is also commonly asserted that opportunity costs for labor during the dry

^{22/} See, for example, Eldon D. Smith and James E. Berry, "A Preliminary Report on the Economics of Fertilizer Distribution and Pricing in Northeast Thailand", Research Bulletin No. 8, Northeast Agricultural Center, Tha Phra, Knon Kaen, Thailand, 1968.

^{23/} One baht equals about five U.S. cents.

season are zero or nearly so. Again, in this particular sample, it was found that thirty-three of the 125 farm families interviewed reported off-farm employment by some family member(s) during the dry season, at an average wage of slightly over 25 baht per day.^{24/}

This opportunity to earn income during the dry season in economic activities other than irrigated farming was found to exert a negative influence on the amount of dry season cropping. Average earnings per day from irrigated farming activities were also good (25 baht per man day); however, farming necessitated assuming production and marketing risks. This factor probably helps to explain why 27 percent of those who cropped less area than they had planned during the dry season indicated a labor constraint (Table 2).^{25/} One might infer from this that either the return to on-farm employment would have to rise

^{24/} It should be noted that this wage is substantially higher than the average unskilled wage prevailing in the area (about 8-10 baht per day) and is biased upward by employment of workers at the dam by the Royal Irrigation Department. The coefficient of variation in average earnings was found to be 121 percent.

^{25/} As an average for all farm households in the Kingdom, non-agricultural activities generated about 40 per cent of total net cash income in 1975, but for the Northeast region the comparable figure was 53 percent. See Ministry of Agriculture and Cooperatives, Division of Agricultural Economics, Agricultural Statistics of Thailand 1975/76.

The importance of non-agriculturally derived cash income of farm households is also documented in a macro-level study conducted at another project site in the Northeast, Lam Nam Oon, where the non-agricultural component of total cash income was calculated to be 62 percent. See MOAC, Division of Agricultural Economics, "Report on the Socio-Economic Survey of the Downstream Portion of the Lam Nam Oon Project, 1976", August, 1976, (mimeo).

substantially or the return to off-farm employment fall in order to encourage significant increases in dry season irrigated farming in the area.^{26/}

A final factor which will be discussed under this general heading of economic factors is the importance of a tested and proven technological package for dry season irrigated production of various crops. Although a fairly substantial public investment has been made in research on dry season irrigated rice production, and to a much lesser extent on other crops, it is probably fair to state that most recommendations are still of a tentative nature. This is true of the agronomic relationships (recommended varieties, time of planting, plant population, fertilization and other soil amendments, plant protection, timing and amount of water application, etc.) but reliable economic data regarding the profitability of alternative practices is even more scarce. Unless and until such information is developed, field tested, and disseminated, it appears unlikely that dry season irrigated cropping will show rapid and continued expansion in the Lam Pao area or in other similar irrigation projects.

^{26/} The problem is much more complex than this, of course. One needs information not only on the off-farm wage rate but also on the total current and future demand for labor in non-farm activities; i.e., how many people will actually have access to these relatively high paying off-farm jobs. The whole area of rural unemployment, under-employment, and seasonal unemployment represents a significant social and economic problem, and one which has thus far been very inadequately researched.

Conclusions and Some Tentative Recommendations

While the following conclusions and recommendations must be regarded as tentative, they are nevertheless based upon an intensive on-farm study in the sample area, an area which appears to be reasonably typical of a number of irrigation projects in Northeast Thailand. The literature and experience in other countries, suggest that some of these findings may be equally applicable to other countries of Southeast Asia.

1. Much greater effort needs to be directed towards establishing effective communication between the Royal Irrigation Department and current and potential users of dry season irrigation. Of particular importance is the careful delineation and mutual comprehension of the rights and responsibilities of the respective parties. A clearly defined mechanism for arbitration and conflict resolution is also needed.

2. The government policy of not making available pesticides for use with dry season rice production until a pest outbreak has been verified should be carefully reviewed. Farmers' expectation of receiving free pesticides from the government limits their willingness to invest their own funds in open market purchases, even though the returns on such investment are likely to be quite high. Either the government program should be reorganized so as to provide pesticides as a preventive treatment (or at least very early in the outbreak) or the program should be scrapped and farmers encouraged to make purchases on

the local market. Similar problems exist in terms of timely availability of credit, fertilizer, and high yielding varieties of rice seed. Efforts to improve this delivery system for key inputs would greatly reduce risk and should increase the adoption rate of the new technology.

3. Increased investment of money and scientific man years in applied research designed to develop economically feasible technological packages for dry season cropping under the specific environmental conditions of the area should have a high payoff. This applied research needs to be followed up with an expanded program of supervised on-farm trials to test recommendations under the actual farm conditions confronting limited resource farmers.

When adequately tested, these recommendations should be communicated widely to the user level through on-farm demonstrations and field days sponsored jointly by RID specialists, agricultural extension agents, and representatives of the regional irrigated crop research stations. Since there is a demonstrated reluctance on the part of producers to seek assistance from government officials even though available evidence suggests that technical assistance is a key factor in expanded technology adoption in the area, those agencies and individuals responsible for extension-type activities will need to assume a more aggressive posture in "carrying the message" to the user level. Furthermore, the positive association between earnings from wet season production and the area cropped under dry season irrigation suggests the importance of treating wet and dry season farming as an

integrated whole when designing extension programs aimed at increasing dry season irrigation use.

4. The importance of profitability and an "acceptable" level of risk in encouraging widespread and rapid adoption of new technology has been demonstrated in numerous studies. The findings of the current study constitute no exception. The close association between controlled irrigation, commercial fertilizer usage, and yield increases is also widely accepted. Fertilizer use in Thailand, however, is far behind many countries of Asia.^{27/} A major reason for this is the price relationship between crop and fertilizer, which may be illustrated with the case of rice. In 1976, at Suphanburi, Thailand, 4.1 kilograms of rice (paddy) were required to purchase one kilogram of nitrogen. Comparable ratios for some of Thailand's neighbors during the same period were: Philippines, 3.6; Indonesia, 2.5; Burma, 1.8; Korea, 1.5; Republic of China, 0.8; and Japan, 0.5.^{28/}

^{27/} Average 1972-74 Thai use of 12 kilograms combined NPK (nitrogen, phosphate, and potash) per hectare may be compared with 21 kilograms in Indonesia, 22 in the Philippines, 53 in Vietnam, 319 in the Republic of Korea, and 341 in the Republic of China. See Asian Development Bank, Asian Agricultural Survey, 1976, Rural Asia: Challenge and Opportunity, Manila: ADB, April, 1977.

^{28/} Data collected by the International Rice Research Institute, Philippines.

This relatively unfavorable factor-product price relationship is due in part to the rice "premium" (export tax), but also to taxes imposed upon imported fertilizer. Currently (January, 1978) this tax is equal to 20 percent of CIF value. Since imports comprise approximately 90 percent of Thai commercial fertilizer use, this amounts to a significant tax which is passed on to the farmer. It would appear that there is little justification for this practice, given the weak capacity for domestic fertilizer production and the significant depressive effect which high fertilizer prices have on agricultural modernization.

5. Government officials should also concern themselves with the likelihood of future marketing problems, in the event that efforts to substantially expand dry season irrigated farming are successful. Problems are likely to be much less acute for second crop rice, for which a fairly effective and efficient marketing system exists, than for vegetables and other less traditional and more perishable crops. Significant price declines for the latter due to unanticipated marketing bottlenecks could exert a very depressing influence on expansion of dry season production.

6. A final general conclusion is that most of the recommendations delineated above do not call for large additional capital outlays by the government. Rather, they require changes in planning,

coordination, organization, administration, and in some cases policy. The important physical infrastructure is already in place in many project areas. What is needed is a concerted government effort to reduce by various means the risk and uncertainty associated with the adoption of the new technology, and to establish a more favorable economic environment that will encourage wider farmer participation in dry season irrigated farming.

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