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9. ABSTRACT

Summarizes progress on numerous models to analyze incomes, labor migration, and employment in Thailand's agricultural sector. The project, conducted jointly by the Thai Division of Agricultural Economics and Iowa State University, is a sub-project in a larger policy analysis covering the entire Thai economy. This report describes the range of models to be included in the sub-project, and reviews the purpose and development of the sub-project's first large-scale linear programming model, the Northeast Regional Model. This model's basic structural equations are provided and results are analyzed. One of the project's major findings is that dry-season unemployment affects much of the Thai labor force. In a discussion of policy implications, the report offers suggestions for providing wider employment opportunities to combat this off-season work shortage. Possibilities covered include the development of cottage industries and employment outside of agriculture, as well as the expansion of livestock production and irrigated areas.

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AGRICULTURAL EMPLOYMENT AND MIGRATION IN NORTHEAST THAILAND: APPLICATION OF A REGIONAL PLANNING MODEL

by

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FOREWORD

This report summarizes initial work in regional rural development as one phase of an agricultural sector analysis project being conducted in the Division of Agricultural Economics (CAE), the Ministry of Agriculture and Cooperatives, Royal Thai Government. The project is a cooperative one between the Division of Agricultural Economics and Iowa State University and is funded by the Agency for International Development.

The overall project has several phases including national and interregional programming models for analyzing policies and five-year plans, macro models of the entire Thai economy, models of the transport and market sectors, and others.

The report which follows explains the initial work completed on regional development of agriculture. Further work on regional economic development is now underway. The analysis in this report relates to the Northeast Region of Thailand. The Northeast Regional Model (NEREGON) includes the 15 northeast Changwats (provinces) of the nation. It also includes five of the Agro-Economic Zones used in constructing the national linear programming model for Thai agriculture. The Northeast was selected for initiating work on regional development since incomes are relatively low, soil and climate are less favorable for crop production, and underemployment of labor is greater than in other regions. This initial study relates to improvement of incomes and employment, mainly through the region's agriculture. Subsequent analyses will consider agribusiness

possibilities, nonfarm industry, and human and public services. The current study revolves around a programming model since, in the short time after the overall project was initiated, data were more readily available for this approach. As other data are accumulated and verified, additional types of models and analyses may be included.

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TABLE OF CONTENTS

	page
INTRODUCTION	1
Setting and Overview	1
Background for Regional Models	4
Objectives and Methodology	11
THE MODEL (NEREGON)	14
Model Structure	15
Base Year Validity Check	21
AGRICULTURAL EMPLOYMENT AND MIGRATION	26
Labor Productivity	26
Demand for Labor in Wet Season	29
Demand for Labor in Dry Season	33
POLICY IMPLICATIONS	37
Expanding Rainfed Upland Production	44
Expanding Irrigated Area	46
Expanding Livestock Production	46
Developing Cottage Industry	47
Developing Employment Outside Agriculture	48
SUMMARY	49
REFERENCES	52

LIST OF FIGURES

		page
1.	Thailand's agricultural zones and regions as specified for analysis and planning	5
2.	Thailand's employment by region and sector, 1970	8
3.	Productivity of agricultural labor in Northeast Thailand - base year 1971-72	28
4.	Normative demand for agricultural labor during wet season in Northeast Thailand - base year 1971-72	30
5.	Normative demand for agricultural labor during dry season in Northeast Thailand - base year 1971-72	35
6.	Labor utilization by month in Northeast Thailand - base year 1971-72	43
7.	Land utilization by month in Northeast Thailand - base year 1971-72	45
8.	Potential labor migration off-farms at alternative wage rates in Northeast Thailand - base year 1971-72	50

LIST OF TABLES

		page
1.	Characteristic features of Thailand's population and agricultural labor distribution by region in 1970	6
2.	Distribution of agricultural land by region and productivity class in 1973-74	9
3.	Average farm income by region and source, 1970	10
4.	Planted area of principal crops in Northeast Thailand - crop year 1971-72	22
5.	Planted area of principal crops in Northeast Thailand under profit maximization - crop year 1971-72	23
6.	Summary of agricultural income and expenses per household by zone in Northeast Thailand - base year 1971-72	25
7.	Optimum utilization of rural labor in Northeast Thailand under alternative wage rate assumptions - base year 1971-72	32
8.	Impact of alternative wage rate assumptions on agricultural income in Northeast Thailand - base year 1971-72	40

INTRODUCTION[1]

The Thailand Agricultural Sector Analysis Program, a cooperative project between the Ministry of Agriculture and Cooperatives (MOAC), Division of Agricultural Economics (DAE) and Iowa State University (ISU), is designed to develop and apply sector analysis models and methods which have practical utility in guiding future development of Thailand agriculture at national, regional, and local levels. Focus of the Agricultural Sector Analysis is on the 21.7 million people living in rural households which make up 63.2 percent of the nation's population. In 1970 the average net income per rural household (5.88 people per household) was $74 from farming. This net income was supplemented by employment off the farm which generated another $102 per year, bringing the total net income for the average household to $176--less than $30 per capita. In contrast, the average income for urban areas was $315 per capita (3, p. 1).

Setting and Overview

The Agricultural Sector Analysis program includes the construction and application of large-scale and sophisticated linear programming models which facilitate evaluation and comparison of alternative policies

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[1]The research reported in this paper was supported by the Royal Thai Government, Iowa State University, and USOM/Thailand through the cooperative Agricultural Sector Analysis Program (AID/CM/SA-C-73-19). The authors are especially grateful for the support and assistance of Dr. Earl O. Heady, Curtiss Distinguished Professor of Economics, Iowa State University and Dr. Somnuk Sriplung, Director, Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, RIG.

and development strategies. The models and research activities are being used to develop detailed and operational policy and planning information for use by administrators and planners. The models are being used to assist in developing agricultural sector plans and continuous analysis of policy alternatives and impact. The national interregional competition model is capable of addressing location-specific objectives, major investments or projects, various commodity and resource development possibilities, the most efficient means of stimulating food production and agricultural productivity, and the economic importance of policies directed toward particular regions, income groups, commodities, foreign trade objectives, and national growth goals. In addition, the national model and supporting research activities are designed to address means of enhancing the contribution of agriculture to other sectors of the Thai economy with particular concern for employment, income generation and distribution, balance of payments, import substitution, export expansion, poverty elimination and integrated development.

The sector analysis models are being developed in a series or sequence of generations, each with increased complexity and analytical capability. The initial crop production models were first used in data validation, and then to analyze selected policy alternatives. In turn, they are the basic structure of the increasingly complex and detailed models to be developed as time and resources are available. When fully operational, the national model will include production activities for all major crop and livestock enterprises in each of the 19 Agro-Economic Zones at various levels of technology and resource substitution, demand

functions for each major commodity group, intrazone and interzone marketing activities (including transportation, storage, and processing), and intersector linkages with the primary sectors which are functionally interrelated to agriculture.

The primary function of DAE policy research is to evaluate direct and indirect economic consequences of implementing specifically stated policy alternatives which may be under consideration. Such policies may cover a wide spectrum of alternatives such as promotion of one or several forms of general economic development, addressing inequities presumed to exist among occupational groups or geographical regions, or the broad category of countercyclical and stabilization policies. While the proponents of various projects and programs usually have an intuitive feel for the general benefits of their proposals, they rarely have a thorough assessment of the direct and indirect quantitative impacts which can be anticipated. Under these conditions, policy research must assess the effects of several performance variables within agriculture and related sectors (4, p. 5).

Although the national, interregional competition linear programming model forms the analytical core for agricultural sector analysis in DAE, other models are being constructed and supporting research conducted simultaneously. Specifically, these include demand analysis, marketing research, macro modeling of intersector linkages, and regional development. The demand analysis is designed to provide point demand estimates for early versions of the national model and demand functions for later generations of the model. The marketing research is designed to provide

an interregional transportation network for early versions of the national model and simulation of storage and processing for later generations. The macro modeling effort is directed to specification and estimation of primary linkages to key resource and market sectors with which agriculture interacts. This brief review is obviously a gross oversimplification of the detailed research effort in each of the major areas mentioned, but it provides a rough outline of the broad scope of the project.

Background for Regional Models

Planning and administration in Thailand is oriented around four major regions (North, Northeast, Central Plain, and South) and each includes three or more planning zones as shown in Figure 1. Each region has a distinct resource base which makes planning for any region a unique situation. The most recent census, which was conducted in 1970 (BE 2513), shows a total population in Thailand of 34.4 million people. The corresponding distribution of population by region includes: North - 22.7 percent, Northeast - 34.0 percent, Central Plain - 30.9 percent, and South - 12.4 percent (Table 1). All of the regions appear to have a high proportion of the population living in rural areas except the Central Plain where Bangkok is located. If Bangkok is subtracted from the Central Plain totals, over 60 percent of the remaining people live in rural areas of this region, also.

Thailand has a total land area of 321 million rai,[2] of which about 109.4 million rai (34.1%) is in farm holdings and 134.6 million rai

[2]One rai equals 0.16 hectare.

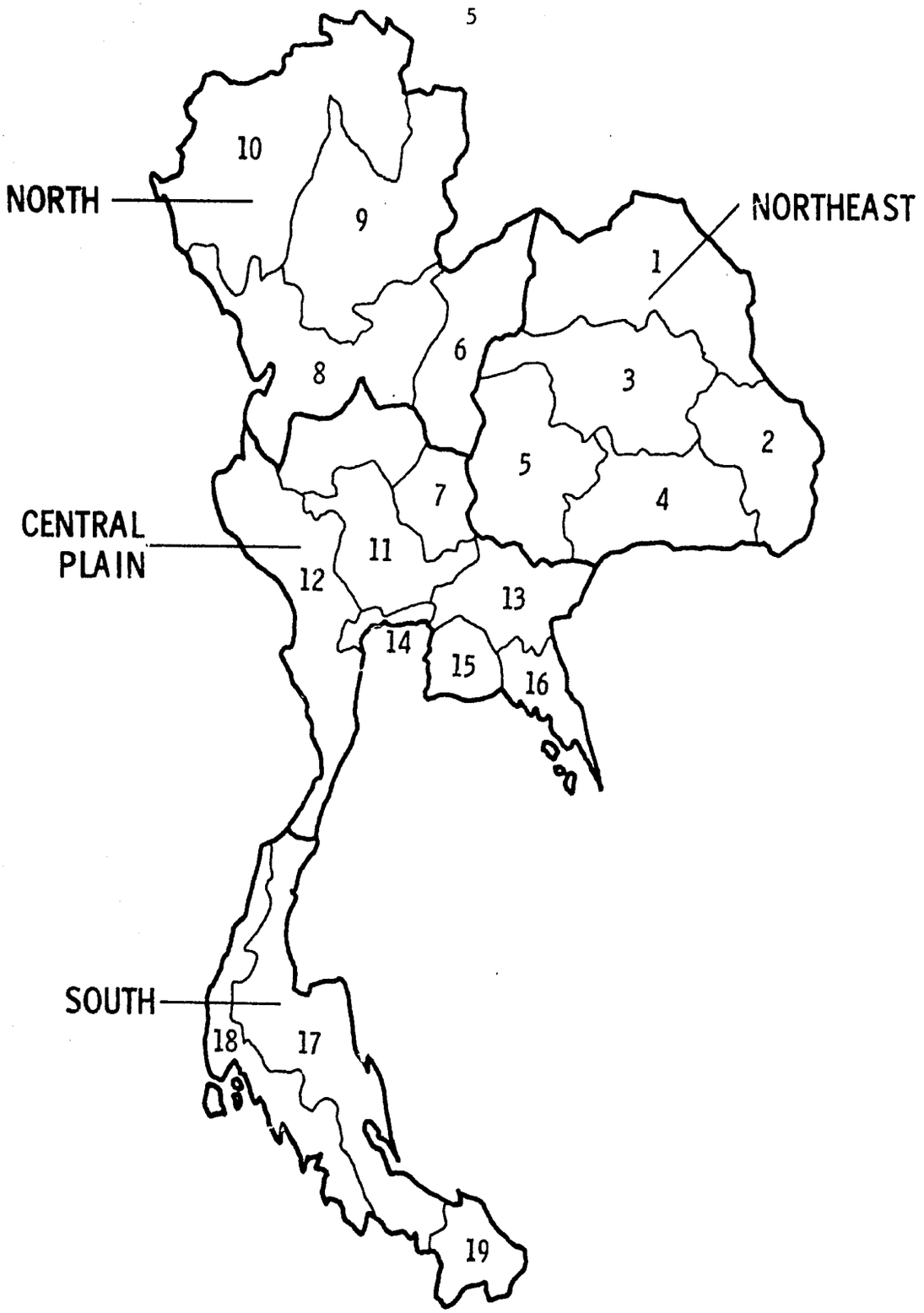

Figure 1. Thailand's Agricultural Zones and Regions as Specified for Development Research Analyses (zones are numbered)

Table 1. Characteristic features of Thailand's population and agricultural labor distribution by region in 1970

Region	Total population	Regional percentage of total population	Agricultural population[a]	Agricultural percentage of regional population	Labor force employed only in agriculture[b]
North[c]	7,813,000	22.7	5,599,613	71.7	1,925,664
Northeast	11,700,000	34.0	9,407,088	80.4	3,145,111
Central Plain	10,612,000	30.9	4,044,385	38.11	2,300,020
South	4,272,000	12.4	2,678,210	62.7	997,325
Thailand	34,397,000	100.0	21,729,296	63.2	8,368,120

[a]Population and Housing Census, National Statistical Office, Office of the Prime Minister.

[b]Estimated by using proportions from 1973 General Survey, Division of Agricultural Economics, Ministry of Agriculture and Cooperatives.

[c]North includes Changwat Loei.

(41.9%) is in forest land. For agricultural planning purposes, major land classifications were aggregated into groups with similar productive and cultural characteristics. The four classes which were developed include: Land I - subject to continuous flooding, suited only to floating rice; Land II - paddy land where controlled irrigation is available during both wet and dry seasons; Land III - paddy land without adequate water supply for irrigation during the dry season; and Land IV - land suited only to production of upland crops. With current low levels of capital inputs in agriculture, land and the labor force essentially form the resource base.

Figure 2 shows the employment patterns for the four regions. None of the regions has less than 20 percent unemployment, implying that land is the limiting resource. The distribution of income by region would be expected to vary according to the distribution of different land classes and the opportunity for off-farm employment. Because of the availability of water during the entire year, and the length of growing season, Land II is capable of double and triple cropping, which makes it very productive. Comparing the data in Tables 1 and 2, it is noted that the availability of Type II land per agricultural resident varies significantly between regions (North-0.68 rai, Northeast-0.25 rai, Central Plain-2.89 rai, South-0.58 rai).

Income from farming varies significantly between regions, as do the off-farm employment opportunities. The net farm income in 1970 ranged from a low of 952[3] Baht per farm in the Northeast to a high of 2,187

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[3]One Baht is equal to approximately U.S. $0.05 (exchange: 20.3 Baht/ $1.00).

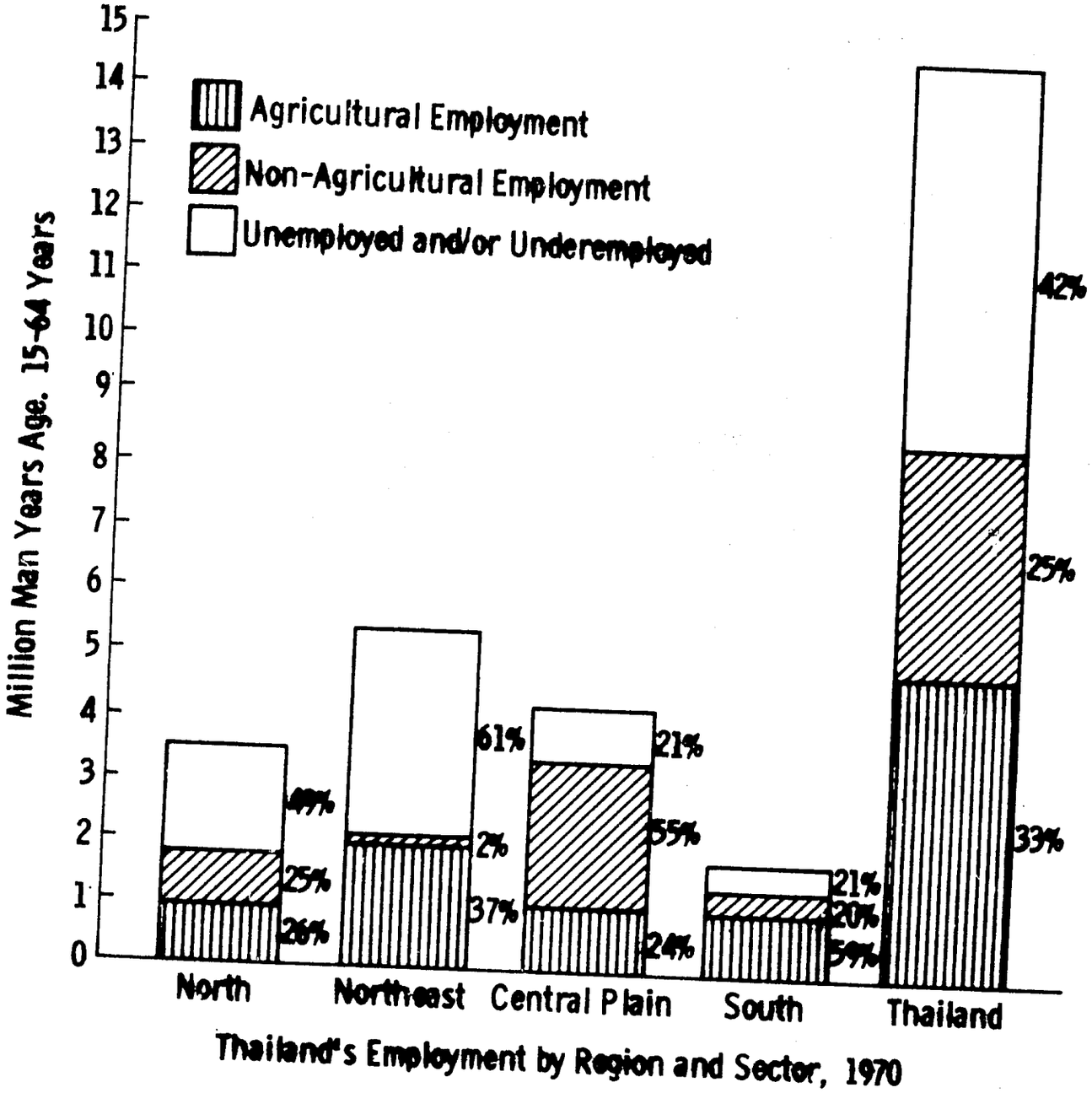

Figure 2. Thailand's Employment by Region and Sector, 1970.
Source: Thailand's Fourth Five-Year Agricultural Development Plan BE2524 Guidelines, DAE, MOAC, RTG, June 1976.

Table 2. Distribution of agricultural land by region and productivity class in 1973-74.

Region	Land Area by Productivity Class (Unit: 1000 rai)				
	Type I	Type II	Type III	Type IV	Total
North	2,591	3,821	8,670	7,145	22,227
Northeast	-	2,333	33,623	7,690	43,646
Central Plain	336	11,670	3,963	6,274	22,240
South	-	1,544	3,015	7,764	12,323
Thailand	2,927	19,365	49,271	28,873	100,436[a]

SOURCE: Thailand's Fourth Five-Year Agriculture Development Plan BE 2524 Guidlines, DAE, MOAC, RTG, June 1976.

[a]Total agricultural land in Table 2 differs from the area sited in the text because land use for roads, canals, farmsteads, and grassland is not included in the four production classes.

Baht in the North (Table 3). Off-farm income varied from a low of 1,064 Baht in the Northeast to a high of 4,585 Baht in the Central Plain. The resulting income distribution of farm families focuses direct attention on the plight of the Northeast farmers. The economic conditions, combined with existing political instability in bordering countries, have made the Northeast a prime area for development in Thailand. The Fourth Five-Year Plan will almost certainly focus on increasing income levels in the Northeast and improving income distribution. Within this setting, the need was clear for a regional model capable of analyzing the employment situation.

Although each of the modeling efforts mentioned earlier is expected to produce analytical models which relate to the problems of the Northeast, most of the focus will be on national policy questions. In contrast, the regional modeling is focused on the development of an independent, sub-national model or set of models capable of analyzing regional specific policies or programs. The regional model can retain and develop much greater detail than can be developed in the national model(s) for practical and computational reasons.

Objectives and Methodology

The concern for improving the welfare of farmers in Northeast Thailand has led to many questions about the productive environment in which he lives and the use of his resources. It is clear that employment reaches rather high levels during the planting and harvesting portion of the wet season, but is also clear that unemployment or underemployment reach high levels during the dry season. Yet, very little is known about the total labor requirements for agricultural production relative to labor

Table 3. Average farm income by region and source, 1970 (Unit: Baht)

Region	Income from farm sources less operating expenses	Income from off-farm employment	Disposable family income
North	2,187	1,602	3,789
Northeast	952	1,064	2,015
Central Plain	1,343	4,585	5,928
South	1,784	2,170	3,954
Thailand	1,486	2,044	3,530

SOURCE: Farm Income and Expenditures in Thailand - BE2513, DAE, MOAC, RIG.

supply. To compound this situation, various individuals and institutions have proposed that the solution to the urban population growth is absorption into the agricultural sector. The real question is, does agriculture have the capacity to absorb more people in order to support general development? Or alternatively, will the nonag sector have to absorb the agricultural surplus in order to support development?

This study develops some benchmark data on agricultural employment and labor productivity in Northeast Thailand. It also relates off-farm wage rates to employment and labor migration. Finally, the study develops guidelines and considerations for increasing employment and income opportunities for farmers in the Northeast.

The labor productivity and employment patterns are traced out through a series of optimization solutions which force the model to allocate resources between competing alternatives based on the relative contribution to the objective function, in this case net income. Thus the LP procedure allocates the resources to the point where their marginal productivity is driven down to cost or some other constraint is reached. In a standard crop production model, labor has no alternative use except in agricultural production. Thus competition for labor is simply between various production activities, and if there is a surplus of labor, labor can theoretically be used in production until the productivity is driven down to zero. By creating an artifical labor hiring activity with an associated price, the system must determine whether the productivity of labor is greater in agriculture than the price on the artificial hiring activity. If not, the optimization procedure requires that the labor be drawn off

in the labor hiring activity. Labor will only be used in agricultural production when the marginal productivity in agriculture is greater than the artificial wage, or price on the hiring activity. It should be made clear that the artificial hiring activity provides no information about how many people can actually find work outside of agriculture. The significant measure is the number of people employed in agriculture, given a specified artificial wage or price on the hiring activity. In other words, those left in agriculture are known to have marginal productivity at least as great as the artificial wage. Combining these characteristics, solutions at a series of artificial wage rates can be used to derive a normative demand for agricultural labor.

Although creation of labor hiring activities for each month would provide a more precise measure of labor productivity, it was felt that this was somewhat unrealistic with respect to potential employment policies or recommendations which might follow from the analysis. It is recognized that there are a finite number of day, week, or monthly jobs which could provide employment for short periods, but it was felt that the majority of off-farm employment opportunities would require continuous employment for several weeks if not several months. As a preliminary analytical methodology, off-farm employment was divided into two periods - seven months during the rainy season and five months during the dry season.

THE MODEL (NEREGON)

The Northeast Regional Model (NEREGON) is the first in the series of regional planning models to be constructed in Thailand. The region under study includes the 15 Changwats (provinces) of Northeast Thailand which have been aggregated into five Agro-Economic Zones for agricultural planning purposes by DAE and MOAC (2). The Northeast covers an area of approximately 99.3 million rai, of which 35.9 million rai is forest area and 25.9 million rai is agricultural land holdings (2, pp. 9-12). Rainfall for the individual zones in the region ranges from a low of 1.112 millimeters per year to a high of 1.656 millimeters. The seasonal distribution of rainfall is uneven, however, and about 22 percent of the annual total comes in one month--August or September, depending upon the specific zone. The region had a population of 11.7 million in 1970, with a total of 1.9 million households, of which 1.5 million were agricultural. In 1970, there were approximately 6.1 residents per household, of which 1.9 were economically active. However, significant differences are apparent between sectors. Agriculture had 3.48 economically active members per household, with only 1.30 per nonagricultural household. The average farm holding in the Northeast was reported as about 30 rai per household in 1970, but only 1.5-2.0 rai of this total holding was the highly productive Type II land. The average farm household in the Northeast includes 6.27 members, based on an agricultural population of 9.4 million.

Model Structure

NEREGON is a linear programming, interzone competition model with five consuming regions and five producing regions. The model contains 902 activities (443 real and 459 slack or disposal) and 409 equations. The activities in the model include one or more production processes in each zone for each commodity on each type of land during each season where production has been observed historically. Separate activities have been defined for the same commodity whenever a distinct production process could be identified that would affect the resource requirements, costs, and(or) yield. Although this does not provide for unlimited resource substitution, it does provide for some basic substitution. As new activities are defined, and the model expanded, further resource substitution will be possible.

In addition to the production activities, the model contains separate supporting activities for each zone. These include: marketing activities for each commodity; subsistence demand (on farm consumption) for selected commodities; capital borrowing by month from institutions, from relatives, and from merchants; and capital transfer activities. The subsistence demand activities are bounded by equalities - lower bounds to force production where necessary, and upper bounds to avoid confusion with off-farm marketing activities.

The Northeast model has separate bound sets for each zone which include land by type and month, labor by month, capital by month, and capital borrowing by source. In addition to the bound sets for each zone, point demand estimates have been added in the form of regional

marketing bounds for each commodity. The point demand estimates serve as upper limits for onfarm consumption and off-farm marketing at the prices specified in the model. These restraints force the five zones to compete against one another for a limited regional market.

In mathematical notation, the model may be written as follows:

Find a set of X's such that,

$$f(x) = CX \tag{2.1}$$

is maximized subject to,

$$AX \leq B \tag{2.2}$$

$$X \geq 0 \tag{2.3}$$

where,

X is a column vector of production, marketing and employment activities;

C is a row vector of unit prices for activities;

A is a matrix of input-output coefficients; and

B is a column vector of resource and demand constraints.

The objective function to be maximized in the model is the sum of off-farm sales, the value of home consumption (valued at wholesale prices), income from off-farm employment, cost of production, and interest charges on borrowed capital.

$$f(x) = \sum_{i=1}^{56} \sum_{j=1}^{5} P_{ij} MK_{ij} + \sum_{i=1}^{56} \sum_{j=1}^{5} P_{ij} SD_{ij} + \sum_{j=1}^{5} \sum_{s=1}^{2} W_{js} LBH_{js}$$

$$+ \sum_{i=1}^{56} \sum_{j=1}^{5} \sum_{\ell=1}^{4} \sum_{m=1}^{12} - C_{ij\ell m} X_{ij\ell m} + \sum_{j=1}^{5} \sum_{k=1}^{3} \sum_{m=1}^{12} - I_{jkm} CB_{jkm} \tag{2.4}$$

where,

P_{ij} is the wholesale price of the i-th commodity (see list at end of model) sold or consumed in the j-th zone (j=1 for Zone 01, 2 for Zone 02, etc.);

MK_{ij} is the marketing (off-farm) of the i-th commodity in the j-th zone;

SD_{ij} is the subsistence demand (onfarm consumption) of the i-th commodity in the j-th zone;

W_{js} is the wage rate for off-farm employment in the j-th zone during the s-th season (s=1 for wet, 2 for dry);

$C_{ij\ell m}$ is the cost of producing the i-th crop in the j-th zone on the ℓ-th land type (ℓ=1 for floating paddy, 2 for irrigated paddy, 3 for nonirrigated paddy, and 4 for upland) starting in the m-th month (m=1 for January, 2 for February, 3 for March etc.). Crop refers to a particular commodity and cultural practice combination. Not all 56 crops are produced in any zone;

$X_{ij\ell m}$ is the rai of the i-th crop produced in the j-th zone on the ℓ-th land type starting in the m-th month;[4]

I_{mjk} is the interest charge for capital borrowed during the m-th month in the j-th zone from the k-th source (k=1, 2, 3 for institutions, relatives, and merchants, respectively); and

---

[4]A detailed description of the cropping activities is included in Working Paper No. 2, Regional Agricultural Development in Thailand: Northeast Crop Model (NEREGON), DAE, MOAC, RTG, April 1975 (5).

CB_{mjk} is the capital borrowing (Baht) during the m-th month in the j-th zone from the k-th source.

Crop production in a given zone is constrained by the total cropland available during a given time period in that zone.

$$L_{\ell m} \geq \sum_{i=1}^{56} X_{i\ell m} \qquad \begin{array}{l} \ell = 1, 2, 3, 4 \\ m = 1, 2, 3.....12 \end{array} \tag{2.5}$$

where,

$L_{\ell m}$ is the amount of ℓ-th land type available in the m-th month; and

$X_{j\ell m}$ is as defined earlier.

Crop production in a given zone is constrained by the total labor available during a given time period in that zone.

$$LB_m \geq \sum_{i=1}^{56} H_{im} X_{im} + LBH_m \tag{2.6}$$

where,

LB_m is the number of hours of labor available for crop production during the m-th month;

H_{im} is the hours of labor required to produce the i-th crop during the m-th month; and

X_{im} and LBH_m are defined earlier.

Crop production in a given zone is constrained by the total capital available during a given time period in that zone. Capital sources include cash or resources on hand plus borrowing from institutions, relatives, or merchants. The constraint is summarized in Equation 2.7:

$$C_m \geq \sum_{j=1}^{56} A_{im} X_{im} - \sum_{k=1}^{3} CB_{km} \qquad m=1, 2, 3....12 \qquad (2.7)$$

where,

C_m is the capital (Baht) available for agricultural production in the m-th month;

A_{im} is the number of Baht required to produce the i-th crop during the m-th month; and

X_{im} and CB_{km} are defined earlier.

However, capital available for borrowing from institutions and relatives is limited as follows:

$$B_k \geq \sum_{m=1}^{12} CB_{km} \qquad k = 1, 2 \qquad (2.8)$$

where,

B_k is the limit of capital supply from the k-th source which can be borrowed during a given year; and

CB_{km} is as defined earlier.

In addition to land, labor and capital constraints, sericulture activities in a given zone, are constrained by the availability of silkworms in that zone.

$$COC_i \geq Z_i X_i \qquad i = 50, 51 \qquad (2.9)$$

where,

COC_i is the available supply of silkworms of the i-th type;

Z_i is the number of silkworms of the i-th which can be supported on one rai of mulberry; and

X_i is the number of rai of mulberry produced for the i-th type of silkworms.

Home consumption and sale of commodities from a given zone is constrained by the amount of commodity produced in that zone.

$$RT_i \geq \sum_{i=1}^{56} \sum_{\ell=1}^{4} \sum_{m=1}^{12} - Y_{i\ell m} X_{i\ell m} + SD_i + MK_i \qquad (2.10)$$

where,

RT_i is the transfer row for the i-th commodity;

$Y_{i\ell m}$ is the yield coefficient for the i-th crop produced on the ℓ-th type land starting in m-th month; and

$X_{i\ell m}$, SD_i, and MK_i are as defined earlier.

Sales are further bounded by a regional market constraint which fixes an upper bound on the total home consumption and sales in the region.

$$RMKB_i \geq \sum_{j=1}^{5} SD_{ij} + \sum_{j=1}^{5} MK_{ij} \qquad (2.11)$$

where,

$RMKB_i$ is the upper bound on the total regional home consumption and sales of the i-th commodity; and

SD_{ij} and MK_{ij} are as defined earlier.

Subsistence demand for a given commodity in a given zone must be met by production in that zone. Column bounds are used to insure that subsistence demand requirements are met before resources are used for production of alternative commodities. Because the same price was used

for subsistence demand and marketing activities, equalities were used on the subsistence demand activities to force sales above subsistence demand to pass through the marketing activities for accounting purposes. The bounds are:

$$SD_i = \sum_{\ell=1}^{4} \sum_{m=1}^{12} Y_{i\ell m} X_{i\ell m} \qquad i = 1, 2, 3....56 \qquad (2.12)$$

where,

SD_i, $Y_{i\ell m}$, and $X_{i\ell m}$ are as defined earlier.

The commodity codes used in the regional model are as follows:

01	Nonglutinous rice	26	Sugar cane, fresh
05	Glutionous rice	27	Sugar cane, processing
09	Maize, feed	28	Tobacco, native
10	Maize, food	29	Tobacco, Virginia
12	Mungbean	35	Tobacco, Turkish
14	Soybean	40	Watermelon
18	Groundnut	50	Sericulture, native
21	Kenaf	51	Sericulture, hybrid
22	Jute	54	Silk cloth, native
23	Cotton	55	Silk cloth, hybrid
24	Castor seed	56	Sericulture, Japanese
25	Cassava		

Base Year Validity Check

Mathematical models such as NEREGON are an abstract attempt to model real world constraints, relationships, and incentives. Therefore, great care must be taken to check the model's ability to approximate actual decisions under previous conditions before extending the model to new alternatives. As previously mentioned, the base year for the original NEREGON model was the 1971-72 year. The recorded production for major crops in Northeast Thailand during the base year is included in Table 4. Similarly, Table 5 summarizes the production pattern resulting from the

Table 4. Planted area of principal crops in Northeast Thailand - crop year 1971-72 (unit:rai)[a]

Code	Crop	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Total
01	Rice, nonglutinous	754,522	396,522	1,042,877	5,358,904	3,337,831	10,890,656
05	Rice, glutinous	5,518,994	4,413,893	5,526,529	1,704,517	1,418,757	18,582,690
09	Maize, feed	2,881	18,757	-0-	39,333	303,910	364,881
10	Maize, food	49,039	6,542	42,312	28,334	30,645	156,782
11	Sorghum	1,668	-0-	500	-0-	1,387	3,555
12	Mungbean	583	-0-	6,741	285	10,027	17,636
13	Soybean	1,720	1,087	1,224	-0-	1,605	5,636
18	Ground nut	24,406	2,423	24,532	10,486	20,016	81,863
21	Kenaf	158,229	259,552	712,460	491,292	776,058	2,397,591
23	Cotton	55,783	1,679	11,034	3,403	31,046	102,945
25	Cassava	14,007	185	29,132	6,550	105,724	155,598
26	Sugarcane, fresh	8,751	228	815	2,365	3,401	15,560
27	Sugarcane, processing	6,524	-0-	-0-	-0-	-0-	6,524
28	Tobacco[b]	44,053	3,200	18,625	15,161	9,392	90,431
31	Coconut[b]						
32	Mulberry[b]	10,532	3,433	92,402	93,444	28,743	228,554
40	Watermelon[b]	26,129	2,929	30,115	11,442	13,310	83,925

[a]Source: DAE, unpublished data.

[b]Department of Agriculture Extension.

Table 5. Planted area of principal crops in Northeast Thailand under profit maximization - crop year 1971-72 (unit: rai)[a]

Code	Crop	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	NE REGION
01	Rice, non glutinous	2,870,115	3,229,950	2,470,378	4,779,428	1,943,057	15,292,928
05	Rice, glutinous	4,086,047	1,497,578	5,640,591	1,129,985	1,566,333	13,920,534
09	Maize, feed	-0-	-0-		34	588,328	588,362
10	Maize, food		22,378	796	28,335	5,511	57,020
12	Mungbean		-0-			917	917
14	Soybean		-0-				-0-
18	Ground nut	34,440	211	24,608	28,301	272	87,832
21	Kenaf	542,389	523,591	1,271,343	456,674	877,350	3,671,347
22	Jute	14,575	-0-	1,464			16,039
23	Cotton	992	-0-			157,918	158,840
24	Castor seed				790		790
25	Cassava	-0-		-0-	178,765	-0-	178,765
26	Sugarcane, fresh					15,238	15,238
27	Sugarcane, processing	6,933					6,933
28	Tobacco, native	428	678	1,404	189,710	1,780	194,000
29	Tobacco, Virginia	922					922
33	Rice, upland, non glut				-0-		-0-
34	Rice, upland, glut				-0-		-0-
35	Tobacco, Turkish			565			565
40	Watermelon	-0-		-0-	208,497		208,497
50	Sericulture, native	9,254	3,095	59,063	29,565	11,931	112,908
51	Sericulture, hybrid	16	1	3	3		23

[a]Source: NEREGON - Solution 3

preliminary optimization of NEREGON. The solution to NEREGON is, of course, based on the resource base, technology, and price structure as observed in the base year survey. Comparing the NEREGON solution with the reported production pattern, there are some differences, but most are not of major significance. For example, Zones 1-3 produce considerably more nonglutinous rice in the model than has been recorded historically. Basically, this shift was at the expense of glutinous rice production. The resulting total area planted to rice deviates by less than 0.9 of 1 percent from the actual area. It is interesting to note that the residents of the Northeast have traditionally preferred glutinous rice for their consumption, but have been shifting to non-glutinous production because it is more profitable. The model appears to have captured the correct economics, but not the full traditional resistance to change. In most of the cases where the model over- or under-produced, the shadow prices indicated that only slight changes in relative prices or technical coefficients would bring the model in direct line with the historic production pattern. In other words, resource productivity is not significantly different in the model solution than in the actual production pattern.

Table 6 contains a summary of income and expenses per household by individual zone and region aggregate. Gross value of the production is the summation of each marketing and subsistence demand activity multiplied by its respective price. Net value of production (income - expenses) for the region is given by the value of the program.[5] No charges were

[5]For the validity check, wage rates on off-farm labor hiring activities were set at zero so that the objective function did not include off-farm income.

Table 6. Summary of agricultural income and expenses per household by zone in Northeast Thailand - base year 1971-72 (unit: Baht)[a]

	Gross value production	Expenses[b]	Net value production	Farm consumption	Net cash sales
Zone 01	5,698.0	1,111.5	4,586.5	1,580.0	3,006.5
Zone 02	5,543.3	1,081.3	4,462.0	1,282.6	3,179.4
Zone 03	6,497.0	1,267.3	5,229.7	3,167.1	2,062.6
Zone 04	6,819.6	1,330.2	5,489.4	2,850.6	2,638.8
Zone 05	4,347.1	848.0	3,499.1	1,494.2	2,004.9

[a]SOURCE: NEREGON - Solution 3.

[b]Not including payments for rent and hired labor.

made for land or labor supplied in the model. The ratio of expenses to gross value of production for the region was then used to calculate expenses for each individual zone.[6] The resulting estimate of net value of production per household is the sum of off-farm sales (cash income) plus onfarm consumption valued at market price. This estimate probably measures farmers' welfare more accurately than cash income when comparing farm and nonfarm income data. However, to compare results from the model with published income data, cash income was estimated by subtracting the value of home consumption from the value of program

[6]This approach to estimating expenses in individual zones assumes a constant ratio of expenses to income. While the regional totals are accurate, values for individual zones are approximate. The ratio was used only as a short cut to a preliminary summary of the data, and not to imply validity as a working assumption for detailed analysis. The actual cost can be calculated by multiplying each production activity by its cost coefficient.

and dividing by rural households. The regional average of 2,525 Baht per household compares favorably with the 2,122 Baht estimate for the Northeast in 1970 (1, p. 178)

AGRICULTURAL EMPLOYMENT AND MIGRATION

Rainfed agriculture which dominates the Northeast has been characterized as having low productivity, limited employment opportunities, and consequently low income. This study focuses directly upon the employment and productivity problems of the agricultural labor force in Northeast Thailand. In 1970, the Population Census reported 5.075 million persons (age 11 years and older) economically active in agriculture. Applying a growth rate of three percent, this expands the labor supply to an estimated 5.227 million in 1971, the value used for the labor analysis.

Labor Productivity

The employment analysis was conducted as a series of 11 solutions to the NEREGON model. Each solution contained the same constraints and activity structure, but differed by the wage rate assigned to the artificial hiring activity. Thus, the optimization process allocated labor among agricultural production activities until the productivity in agriculture fell below the wage rate set on off-farm employment. The model was solved at 1.0, 2.0, 2.5, 3.0, and 3.5 Baht per day, and then in 4.0 Baht increments starting at 4.0 Baht per day and going to 24.0 Baht per day. At the time of the study, the minimum wage rate in Bangkok was set at 20 Baht per day. As in many countries, however, agricultural labor does not fall under the minimum wage law. An 8.0-10.0 Baht range was far more common in

agriculture than the 20 Baht minimum, with higher rates being paid for special types of work or during critical seasons such as planting and harvest.

The standard theoretical resource production function has total product increasing at increasing rates up to some point where diminishing marginal returns begin. From here, the function continues to increase, but at a decreasing rate, until maximum product is reached. This point corresponds to the point where marginal product has fallen to zero. Beyond this point, total product falls as long as additional resources are added. Unlike the standard form, labor production functions seldom display increasing marginal returns over any significant range. Within the range of employment considered in the labor model, no increasing marginal returns were experienced. Marginal product is at a relatively high rate (22.71 Baht per day) with a full-time equivalent employment of approximately 2.0 million, and falls to zero at just over 3.18 million (see Figure 3). Average productivity of labor is 6.571 Baht per day at the 2.0 million level. Thus, this level of employment is in Stage Ib of production (MP>AP, but MP is falling). Stage II, the rational area of production, is reached at employment of about 2.44 million. At this point marginal product has fallen to just over 7.0 Baht per day, and average productivity has been pulled up over 7.0 Baht per day. Beyond this point, average product falls gradually throughout the remainder of the employment range. This information provides the basis for discussing employment, unemployment, labor returns, and optimum levels of labor utilization.

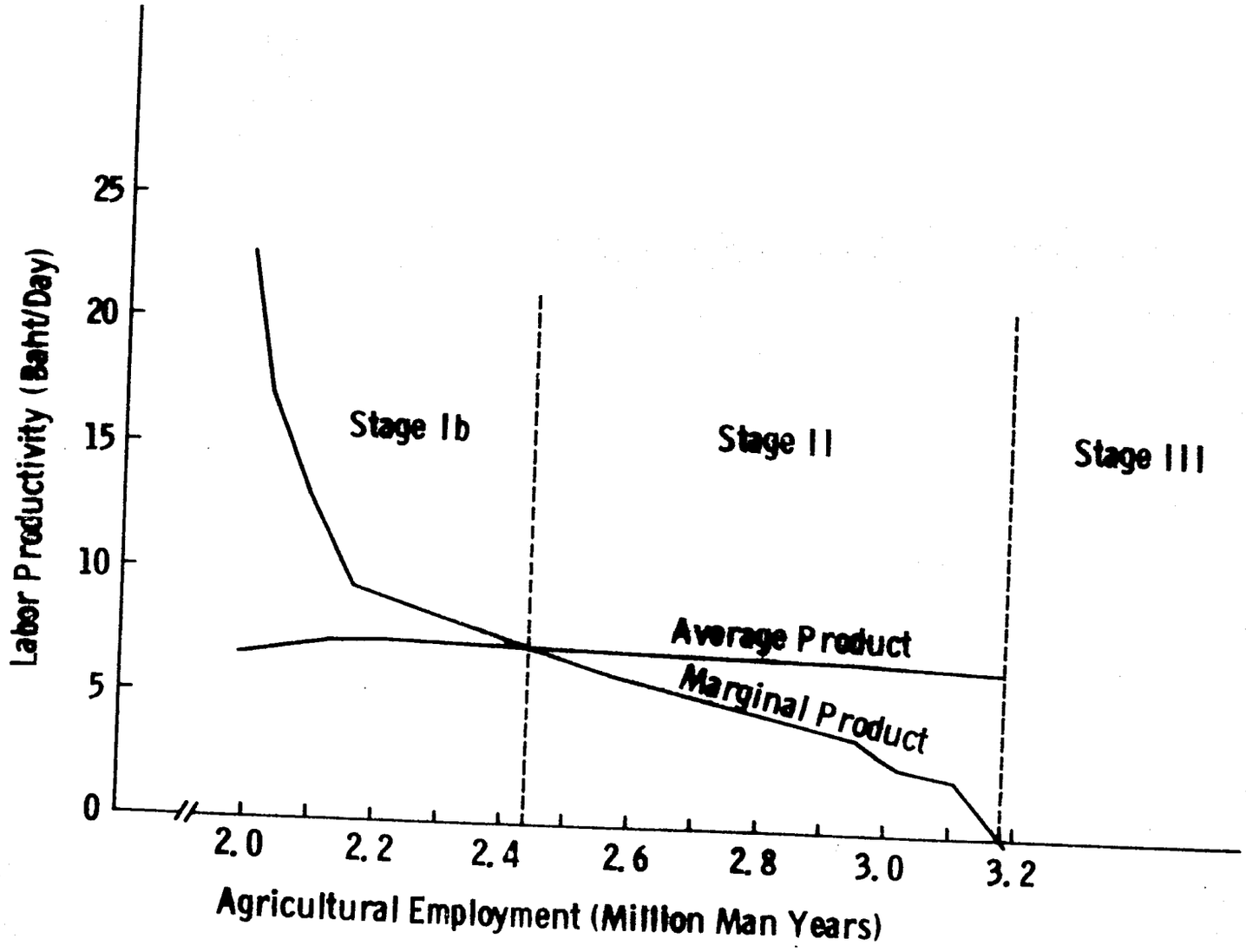

Figure 3. Productivity of Agricultural Labor in Northeast Thailand. Base Year 1971-72[a]

[a]Source: NEREGON - Solution 13 and 14.

Demand for Labor in the Wet Season

Beginning at a low wage rate for off-farm employment, all of the labor force was employed during the wet season[7] when the artificial off-farm wage rate was one and two Baht per day. This says that the marginal productivity of the 5,227,086-th worker was equal to or greater than 2.0 Baht per day (360 Baht for the season). Many of the workers generate net product (value product minus expenses) considerably higher than 2.0 Baht per day, as will be shown later, but at minimum everyone's productivity exceeds the 2.0 Baht per day level.

When the off-farm wage rate was raised to 2.5 Baht per day, some of the labor was pulled out of agriculture, as shown in Figure 4. The model indicates that, given the resources, technology, and agricultural production practices defined in NEREGON, a little over 200,000 people had a productivity of less than 2.5 Baht per day in agriculture. Comparing this with the previous solution, we know that the productivity of these 200,000 people is specifically more than 2.0 Baht but less than 2.5 Baht per day. Because the labor-hiring activity is defined for the entire wet season, we cannot say that none of the 200,000 would have productivity greater than 2.5 Baht for any given day or other period shorter than the whole season. But, we do know that their net productivity in agriculture is more than 360 Baht and less than 400 Baht for the entire wet season.

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[7] Wet season is defined to coincide with the main rice production season in the rainfed areas, 180 working days from June through December.

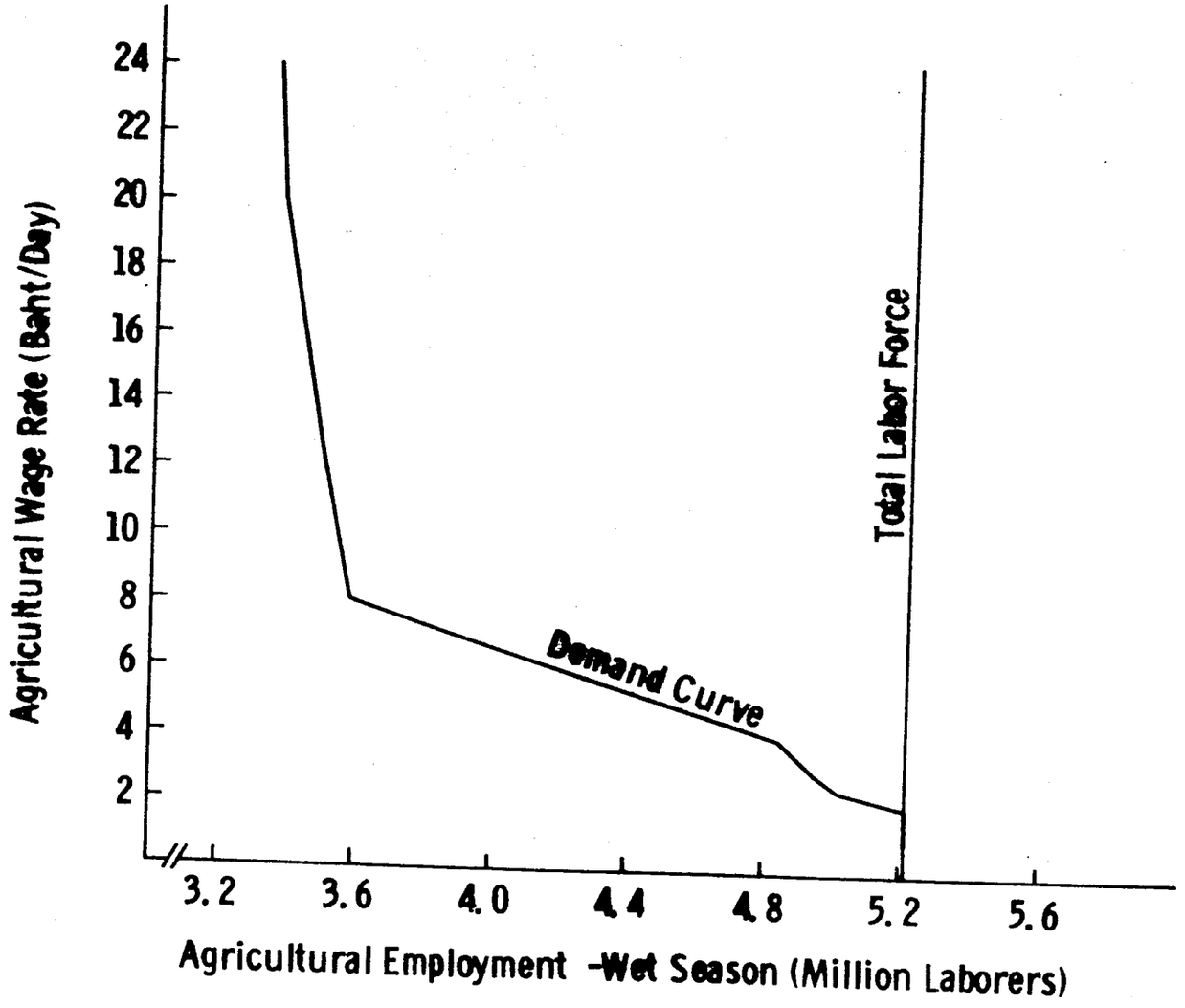

Figure 4. Normative Demand for Agricultural Labor During Wet Season on Northeast Thailand--Base Year 1971-72[a]

[a]Source: NEREGON - Solutions 13 and 14.

As the artificial wage rate increased from 2.5 to 4.0 Baht per day, the number of workers employed in agriculture dropped from just over 5.0 million to 4.85 million (Table 7). This identifies 70,462 people as having marginal productivity for the wet season between 400 and 540 Baht, 49,094 between 540 and 630 Baht, and 50,675 between 630 and 720 Baht. At this point the model has identified 4.85 million workers (92.8 percent) as having a minimum marginal productivity for the wet season of more than 720 Baht, and another 376,251 as having productivity ranging from 360 to 720 Baht per day. The marginal productivity of the 376,251 workers as a group is 2.676 Baht per person per day, or 481.7 Baht for the wet season.

As the daily wage on the off-farm labor activity increases from 4.0 to 8.0 Baht per day, there is a major drop from over 4.85 million employed in agriculture to just under 3.6 million. This says that there are approximately 1.25 million agricultural workers in Northeast Thailand whose productivity for the wet season exceeds 720 Baht, but is less than 1,440 Baht. From 8.0 Baht on up to 24.0 Baht per day, the number of people employed in agriculture gradually decreased by another 200,000. Approximately two-thirds of the agricultural labor force (3.49 million) had a marginal productivity in agriculture of more than 12 Baht per day or 2,160 Baht for the wet season. The other 1.73 million workers have a marginal productivity of 5.50 Baht per day, or 990.0 Baht for the seven months of the wet season. If their only production and employment is during the wet season, this would imply that the

Table 7. Optimum utilization or rural labor[a] in Northeast Thailand under alternative wage rate assumptions - base year 1971-72[b]

Wage Rate (Baht/Day)	Wet Season			Dry Season			Index of Ag Income
	Onfarm	Off-Farm	Percent	Onfarm	Off-Farm	Percent Onfarm	
1.0	5,227,086	-0-	100.0	820,501	4,406,585	15.7	100.0
2.0	5,227,086	-0-	100.0	818,513	4,408,573	15.7	100.0
2.5	5,021,066	206,020	96.1	748,254	4,478,832	14.3	98.4
3.0	4,950,604	276,482	94.7	733,513	4,493,583	14.1	97.9
3.5	4,901,510	325,576	93.8	729,142	4,497,944	14.0	97.4
4.0	4,850,835	376,251	92.8	720,350	4,506,736	13.8	96.9
8.0	3,589,431	1,637,655	68.7	629,882	4,597,204	12.1	75.9
12.0	3,492,367	1,734,719	66.8	540,377	4,686,709	10.4	71.9
16.0	3,451,436	1,775,650	66.0	33,825	4,793,261	8.3	68.1
20.0	3,379,792	1,847,294	64.7	396,009	4,831,077	7.6	63.7
24.0	3,360,412	1,866,674	64.3	392,141	4,834,945	7.3	62.4

[a]Total labor supply estimated at 5,227,086.

[b]Source: NEREGON - Solution 13 and 14.

equivalent of 498,482 households[8] have an annual income of 3445.2 Baht, or 549.5 Baht per capita.

At 24.0 Baht per day, the demand for labor in agriculture is down to 3.36 million, or 64.3 percent of the available labor force. The other 1.867 million have been drawn out of agriculture by the artificial hiring activity because their productivity is less than 24.0 Baht per day, or 4,320 Baht for the season in agriculture. As an aggregate group, the 1.867 million workers have a marginal productivity in agriculture of 6.34 Baht per day.

Demand for Labor in the Dry Season

In sharp contrast to the wet season employment, at a competitive wage rate of 1.0 Baht per day during the dry season,[9] only 820,491 of the 5.2 million people in the agricultural labor force would be employed in agriculture. Thus only 15.7 percent of the labor force had a marginal productivity in agriculture of at least 1.0 Baht per day. That amounts to a total labor return of only 125 Baht for the whole dry season, or 25 Baht per month. Unlike the employment pattern in the wet season, the change in employment during the dry season is nearly a linear function from 1.0 to 24.0 Baht per day.

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[8] 5,227,086 workers from 1.5 million households = 3.48 members per household.

[9] 9,407,088 residents from 1.5 million households = 6.27 members per household.

[10] Dry season is defined as the season when there is insufficient rainfall for extensive crop production in the Northeast, 125 working days from January through May.

When the off-farm wage was raised to 2.0 Baht per day, some additional labor was drawn out of agriculture, as shown in Figure 5. Given the resources, technology, and production practices defined in NEREGON, less than 2,000 people had a productivity greater than 1.0 Baht but less than 2.0 Baht per day. Again, we cannot say that none of these or the previous group ever have productivity greater than 2.0 Baht for any given day or short period, but we can say that their productivity for the dry season is less than 250 Baht, with 4.4 million being less than 125 Baht.

As the artificial wage rate increased from 2.0 to 2.5 Baht per day, 70,259 workers were drawn out of agriculture. This identifies 70,259 people as having productivity for the dry season between 250 and 312.5 Baht. Another 14,741 employed were taken out of agriculture when the off-farm wage rate was raised from 2.5 to 3.0 Baht, pinpointing their productivity at 312.5 to 375 Baht for the dry season. As the wage raised from 3.0 to 3.5 and 3.5 to 4.0, respectively, 4,371 and 8,792 workers were drawn out of agriculture. At 4.0 Baht per day the productiviy is only 600 Baht for the dry season or 120 Baht per month. The marginal productivity of the 4.5 million people drawn out of agriculture up to the 4.0 Baht wage rate is 0.544 Baht per day or 68.0 Baht for the season. At 3.48 workers per 6.27 member household, this implies that the equivalent of 1.295 million households have a marginal productivity of 236.6 Baht for the five month dry season, or 37.7 Baht per capita. If all the low productivity workers are not in roughly 1.295 million households, but evenly distributed over all households, this implies

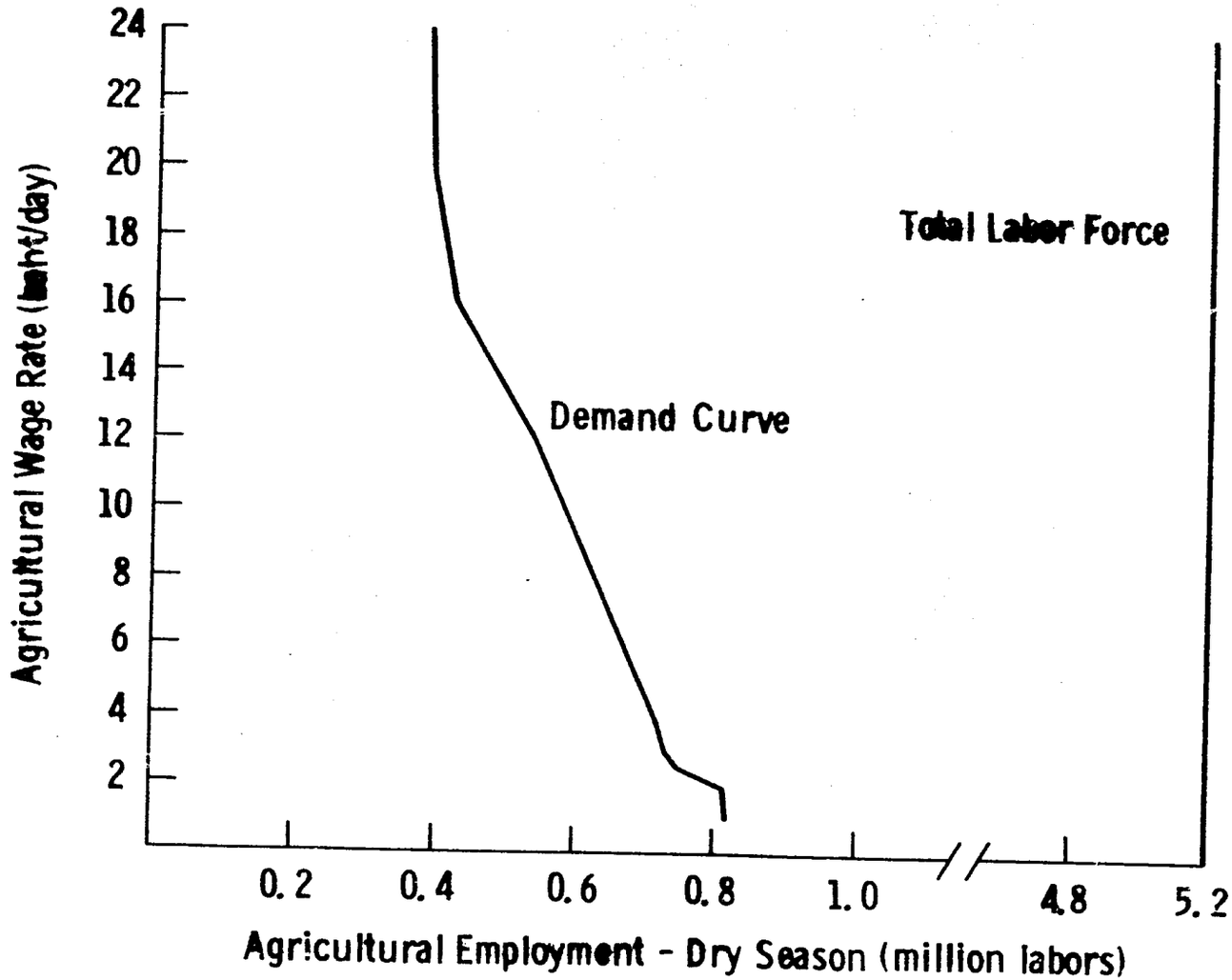

Figure 5. Normative Demand for Agricultural Laobr During Dry Season in Northeast Thailand--Base Year 1971-72[a]

[a]Source: NEREGON - Solutions 13 and 14.

that all households would have a proportionately lower income. The latter would most likely be the case if resources (land, capital, etc.) were distributed evenly to all households, but concentrations of low productivity may occur when households or whole geographic areas have limited resources to combine with the available labor.

As the wage rate for off-farm employment increased from 4.0 to 8.0 Baht per day, 90,468 more workers left agriculture. From 8.0 to 12.0 Baht another 89,505 were removed. From 12.0 to 16.0, 16.0 to 20.0 and 20.0 to 24.0, the release from agriculture amounted to 106,552, 37,861, and 3,868, respectively. Aggregating the entire labor force whose marginal productivity is less than 24.0 Baht per day (4.8 million workers), the marginal productivity of each worker is only 1.271 Baht per day or 158.9 Baht for the five month dry season. This implies that the equivalent of 1.389 million households have a marginal productivity of only 552.9 Baht for the five month dry season, or less than 90 Baht per person for the five month period.

To put these income figures into perspective, the average per capita consumption of white rice in the rural area of the Northeast is slightly over 160 kilograms per year. During the last few years, rice price has been rising in Thailand, but 45 Baht per Tang (15 kilograms) is a conservative price. The value of rice consumed per household during the dry season would be approximately 1030 Baht. Consequently, over 92 percent of the rural population has income equal to less than 55 percent of the value of rice alone consumed during the dry season. Another way of making the comparison is to say that each worker must have a productivity

of at least 1.5 Baht per day to buy his own rice, or 2.7 Baht per day to support himself and his share of the family (about 1.8 family members per worker). Those employment opportunities are available to approximately 5.0 million during the wet season and only about 750,000 in the dry season.

Labor productivity is low in Northeast Thailand, especially during the dry season. This, of course, is not a reflection on the laborers, but upon the resource combinations available for production. In general, the model provides for varying amounts of labor to be applied to a fixed resource and technology base. However, the model does have some flexibility in making resource substitution by choosing different types or levels of technology as defined by different activities to produce the same commodity. In this study, no major resource changes were introduced, such as massive irrigation projects, etc. Major changes in the resource base would most certainly change the productivity of labor, employment opportunities, and income potential.

POLICY IMPLICATIONS

A great deal has been written and said about the low income level of farmers in Northeast Thailand. The striking aspect of this study is the massive number of people who are unemployed or underemployed during the dry season. Statistics on actual unemployment are not available, but the model indicates that only 820,000 have marginal productivity greater than 1.0 Baht per day, leaving 4.4 million virtually unemployed. One alternative for employment is in the nonag sector. Again, exact

estimates of labor migration from agriculture to nonag jobs are not available. The Population Census does list the number of people economically active and employed in the nonag sector. The number employed actually exceeds the number economically active by 492,346. Although this is not a precise estimate of migration from agriculture to nonag, it is a rough estimate of the upper bound for off-farm employment opportunities for the agriculturel labor force. The roughly 500,000 job opportunities compare favorably with the potential migration off-farm during the wet season if real wage rates are 4.0 Baht or less, but provides less than one-third the desired jobs at wage rates of 8.0 Baht per day (Figure 4). During the dry season, the off-farm job opportunities are nearly 4.0 million less than the potential migration at wages of 4.0 Baht per day (Figure 5). Underemployment can be defined as having marginal value product equal to or less than zero. The model indicates that 3.2 million people have a positive marginal productivity, and just over 2.0 million make no significant contribution. That amounts to more than 600 million man days of labor. The need for diversified agriculture or agricultural related jobs is clear.

Several solutions have been proposed to the employment problem. One line of thought focuses on redistribution of the land as a means of increasing employment. This approach will work if the resource base is not being fully utilized, and redistribution would lead to more intensive utilization. Redistribution is also desirable if the resources are not evenly distributed, and labor is being exploited by the resource owners. However, it should be noted that if the resources are being used as

intensively as they will be under redistribution, and the wage rate reflects true productivity, resource redistribution will not improve either employment or income levels. Various degrees of success have been experienced in other countries, ranging from significant increases in production to significant reduction. The key is how intensively the resources are used before and after redistribution because the base remains unchanged.

A second line of thought focuses on development of the nonag sector to create off-farm employment opportunities which can absorb the surplus labor from agriculture. The impact of the increased employment opportunities can be measured directly from the labor model. With an assumed wage of 1.0 Baht for nonag employment, the total income from agriculture and nonag employment was 7,427.3 million Baht, or 4,951.5 Baht per household. As the wage rate on the artificial hiring activities was increased, the value of the program (objective function) increased steadily (Table 8). The higher program value, of course, means higher per capita income levels in the agriculture sector. At 24.0 Baht per day, the value of program reached 17,755.6 Baht per household with 14,891.2 Baht coming from off-farm employment.

Although the higher level of income is desirable, there are two obvious problems. At the 24 Baht level, 3.05 million full-time equivalents are drawn out of the labor force. That represents 2.5 million more jobs than apparently are now available. On the other side, the reduction of the agricultural labor force by 3.05 million lowered agricultural production per household from 4,590 Baht to 2,864 Baht. Thus,

Table 8. Impact of alternative wage rate assumptions on agricultural income in Northeast Thailand - base year 1971-72[a]

Wage rate	Value program	Wet season labor	Dry season labor	Net ag income	Index of ag income
	(million Baht)	(million Baht)	(million Baht)	(million Baht)	
1.0	7,427.3	-0-	542.0	6,885.3	100.0
2.0	7,969.4	-0-	1,084.0	6,885.4	100.0
2.5	8,246.3	92.7	1,377.2	6,776.4	98.4
3.0	8,545.2	149.3	1,658.1	6,737.8	97.9
3.5	8,849.8	205.1	1,936.4	6,708.3	97.4
4.0	9,158.6	270.9	2,217.3	6,670.4	96.9
8.0	12,105.2	2,358.2	4,523.6	5,223.4	75.9
12.0	15,618.2	3,747.0	6,917.6	4,953.6	71.9
16.0	19,232.7	5,113.9	9,433.1	4,685.7	68.1
20.0	22,921.5	6,650.3	11,884.4	4,386.8	63.7
24.0	26,633.4	8,064.0	14,272.8	4,296.6	62.4

[a]Source: NEREGON - Solution 13 and 14.

increasing income for agricultural workers through nonag employment opportunities may be in direct conflict with development objectives to expand agricultural production. A careful examination of Table 8 shows that there is a direct trade-off between providing income through off-farm employment opportunities and maintaining agricultural production. It should be noted that the negative impact on agriculture might not be as large as indicated, because the model does not anticipate any behavioral change in the labor left in agriculture. The model assumes the number of hours worked per day and work performance remain constant. The model does have capability to make some technical and capital substitutions for the migrating labor, but the extent of substitution is restricted to the range of activities currently defined within the model.

The feasibility of absorbing surplus agricultural labor in the nonag sector is questionable--at least at the levels implied in the labor model. Many planners in Thailand have assumed that agriculture would be able to absorb the surplus labor from the nonag sector since industrial development appears to be lagging behind growth of the population and labor force in that sector. It is true that within the cultural setting, a certain amount of labor migration from urban to rural areas has taken place when unemployment rose in the urban areas. Faced with unemployment in urban areas, workers tend to migrate back to the "family" in rural areas where food is generally available, cost of living is lower, and some productive activities are available. This is private "welfare or social security" at work, but it does not mean that agriculture absorbed the extra labor out of need. In fact, the data in this study

indicate that agriculture in the Northeast already has a sufficiently large labor supply within the sector to drive the marginal productivity of labor to zero. Without new infusions of technology and resources to increase labor productivity, Northeast Thailand has no capacity to absorb labor without driving down the average income. Absorbing labor in agriculture at this time only intensifies the underemployment or disguises unemployment which already exists in agriculture.

Another alternative for dealing with the employment and income problem is a broad comprehensive plan to expand agricultural productivity while simultaneously developing off-farm employment opportunities. The essence of this approach is to increase labor productivity in agriculture and to provide some nonag employment opportunities. Focus on agricultural development must be on resource utilization. First indications would be that only the dry season has a significant surplus of labor, but the labor utilization can be broken down further from the aggregate season summaries presented earlier. Consistent with the aggregate summaries, labor utilization is much higher from June to December than from January to May, but significant differences between months are apparent (Figure 6). The heavy demand periods are obviously at planting and harvest, while midseason employment is relatively low.[11] Employment during the dry season is uniformly low. This would lead one to the conclusion that diversifying agriculture to provided employment during the middle of the wet season and during the dry season would be helpful. It is necessary, however, to compare the labor use with land use patterns before reaching a conclusion.

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[11] Solution 3 did not contain adjustments for livestock labor demands, and thus the full labor force was not utilized as in the labor analysis solutions.

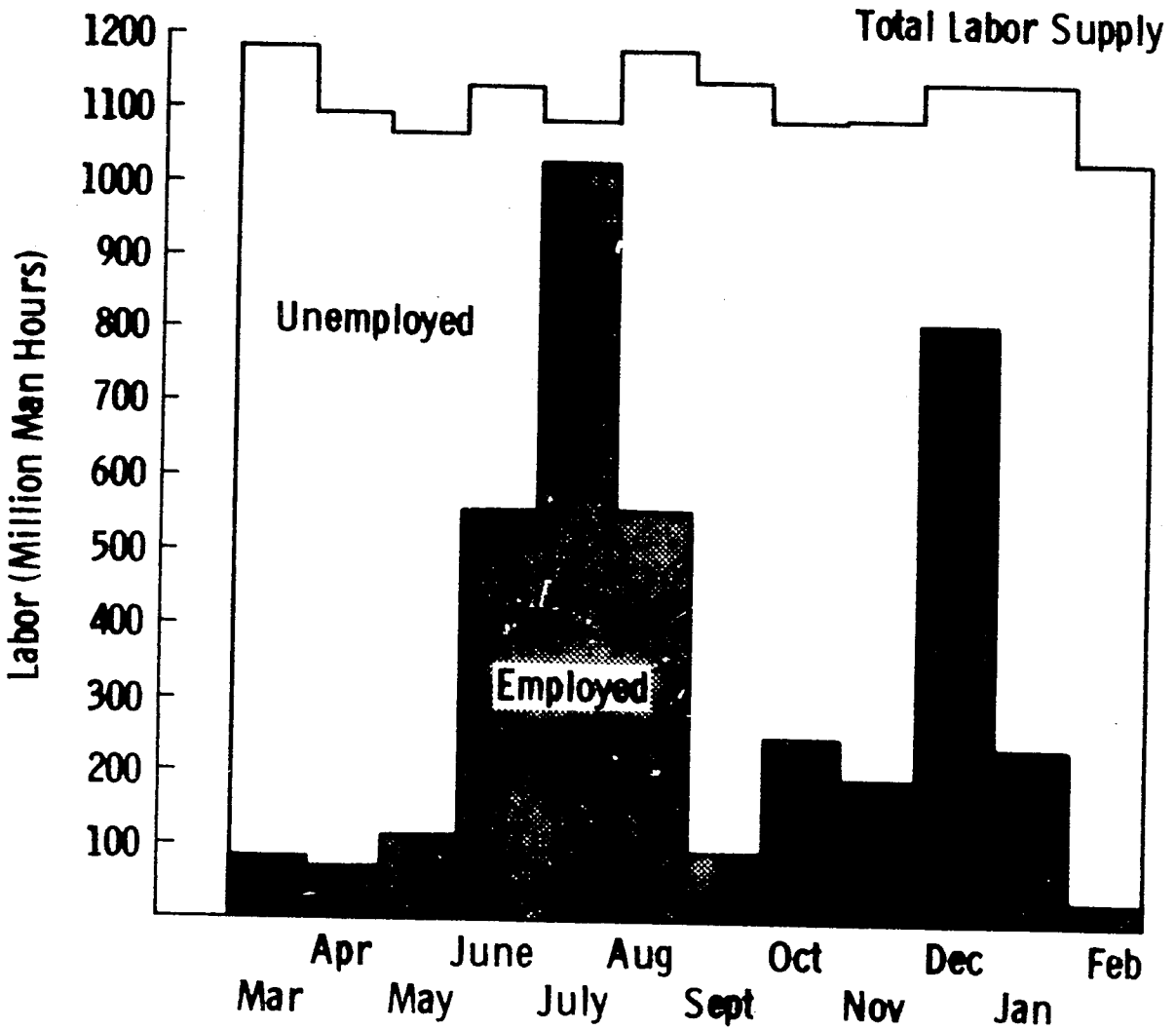

Figure 6. Labor Utilization by Month in Northeast Thailand--Base Year 1971-72[a]

[a]Source: NEREGON - Solution 3.

Land utilization does not exhibit the same distribution patterns. There is limited opportunity to increase agricultural production during the wet season, except through improved technology (Figure 7). Land utilization only drops off significantly during the dry season, which is directly related to the lack of adequate rainfall for extensive crop production.

Combining the labor and land use patterns, several alternatives begin to emerge as possible development alternatives. Those discussed here will not be exhaustive of all alternatives, but will provide some guidance in the types of programs that might be considered.

Expanding Rainfed Upland Production

The availability of land and labor during the dry season suggest that production of upland crops might be a potential during this period. Obviously there is not adequate incentive or the farmers would be doing this already. If the domestic market does not exist, it may be appropriate to tie this region directly into an export market. Again, the assumption is that a viable export market does exist at prices high enough to promote production. The other half of economic incentive is that production imputs must be available at reasonable prices and producers must be able to correctly anticipate favorable market prices. Adequate evidence is available in Thailand to support the hypothesis that even small farmers will respond to a favorable economic climate.

If on the other hand, production is constrained by lack of water, the problem has significantly different dimensions. There is strong

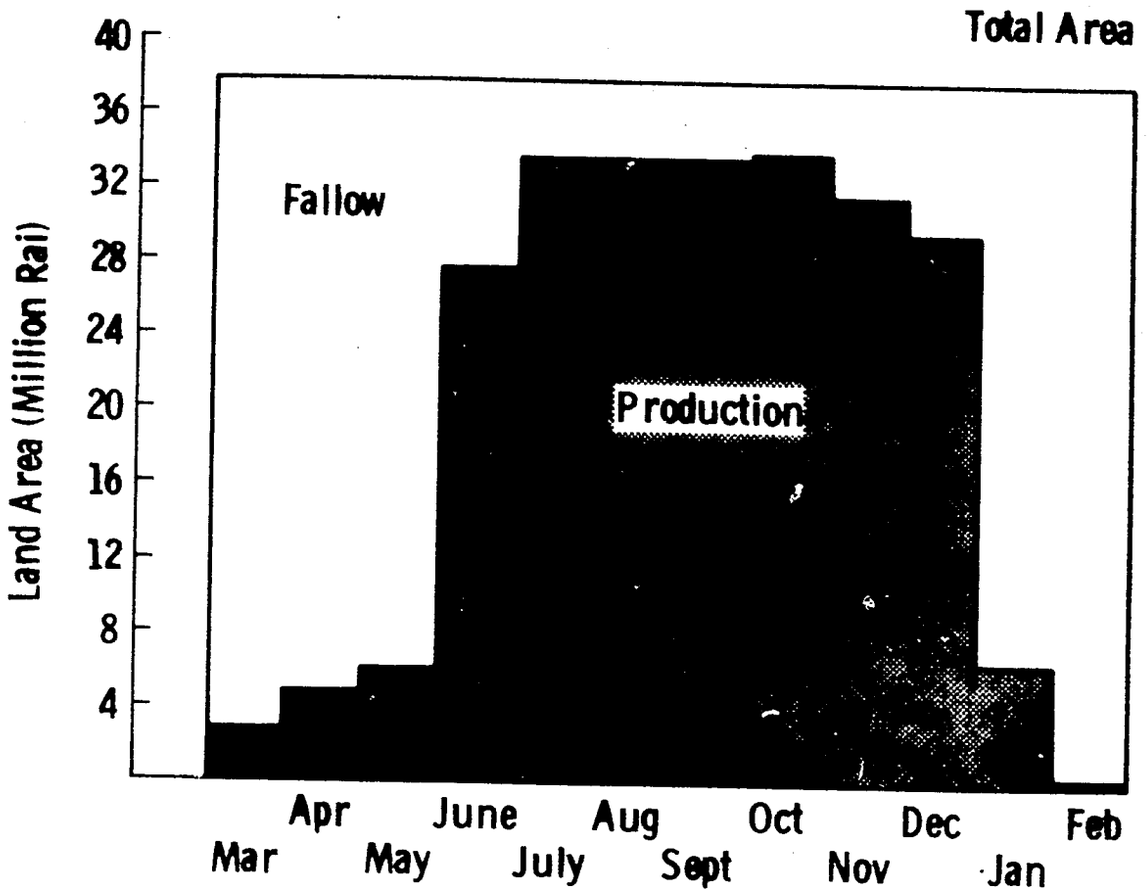

Figure 7. Agricultural Land Utilization by Month in Northeast Thailand--Base Year 1971-72[a]

[a]Source: NEREGON - Solution 3.

evidence that the water constraint is the major constraint since income and employment did not change significantly when production of selected export commodities increased significantly under alternative price assumptions in various supply response studies.[12] Production of the export crops responded to various price incentives, but in general the expanded production caused reductions in production of other crops. The impact on employment was negligible.

Expanding Irrigated Area

If water is the constraining resource as it appears, then irrigation projects have a very high priority for consideration. Northeast Thailand has more than 68 percent of the nation's Type III land (paddy without water for multiple cropping). If irrigation facilities could make water available for year around production, the productivity of the region could be increased significantly. Only careful analysis of the potential for irrigation can determine the extent of feasibility and cost to change the land productivity. Again careful consideration should also be given to what crops might be replaced -- specifically whether exports and balance of payments would be affected.

Expanding Livestock Production

There is a viable livestock industry in the Northeast. The farmers have demonstrated a willingness and ability to engage in livestock production. If production patterns could be developed which minimized labor

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[12] Supply response studies have been completed on rice, maize, cassava, and kenaf (6, 7, 8, 9).

requirement during peak cropping seasons, livestock could be very complimentary to the cropping program. The area is already a large producer of rice (cracked and bran), maize, and cassava which could serve as feed inputs for the livestock program. Soybeans, as one protein source, are adaptable in the region and are grown in even greater quantity in the nearby Northern Region. In preliminary solutions to combination crop and livestock models for the Northeast, there is some indication that any significant increases in ruminant livesotck which are fed a high roughage ration will quickly bring the roughage demands in competition with cash crop production. Further analysis will be possible when the livestock models are complete. If the competitiveness can be avoided, livestock promotion may be a viable means of increasing employment and income in the Northeast. Production of silkworms is another proposal which has received considerable support.

Developing Cottage Industry

Various projects have been proposed which fall into the cottage industry class. Directly related to the production of silkworms is the spinning of silk thread and weaving of silk cloth. These activities are already a part of life in the Northeast. They adapt well to onfarm production or enterprises organized on a village level. This type of activity has the advantage of flexibility so that it need not compete for labor during peak seasons of crop production, but can provide extensive employment opportunities during off-season periods. The cottage industries allow workers to remain in rural areas without being forced to migrate to urban areas in search of employment.

Developing Employment Outside Agriculture

The most promising activities in this category are those directly related to agriculture such as processing. Processing activities would serve the dual purpose of providing employment for labor in nonag production, and would also create a regional demand for basic commodities. This would be especially true for commodities with high perishability, such that shipment out of the region for processing would be virtually impossible. Development of processing facilities in this case would not only help increase demand and price of the commodity, but could open an entire new market. Once again, such a proposal must be analyzed within the whole national setting. Will development of processing facilities in the Northeast for selected commodities cause production to relocate from other areas or will it stimulate increased production? If the first, what impact will this have on employment and income in other areas? If the latter, is domestic demand expanding rapidly enough to utilize the increased supply without depressing prices or is there sufficient export demand to help clear the market? Currently, a great amount of discussion is focused on location of sugar and cassava processing facilities. Canning facilities for fruits and vegetables could also be considered.

How much labor is available, and what wage rates are necessary? The two questions are actually closely related. Based on the results reported in this study, a wage rate of as little as 1.0 Baht per day would represent an economic opportunity for approximately 4.4 million workers during the dry season. Not all workers would respond to the

opportunity because some are very young and some simply prefer the agricultural employment. Salaries of 16.0 Baht per day would represent significant economic opportunities. If all workers responded on strictly economic terms, Figure 8 shows the potential migration out of agriculture during the dry season. As indicated before, the problem with standard industrial operations under these conditions would be the great fluctuation in labor supply between the wet season and dry season. In contrast, a wage of at least 8.0 Baht per day is necessary to provide an economic opportunity for workers during this season. Furthermore, a wage above 8.0 Baht would not significantly change the number of workers available for off-farm employment. If a plant could operate on some reduced schedule during the key planting and harvesting months, more of the labor force should be available for off-farm employment than with a continuous schedule.

None of the statements about wages are meant to imply what the minimum wage should be in rural areas. Instead the discussion is presented to explain what labor productivity is in agriculture, and what would be necessary to create a viable employment opportunity where the benefits were greater than the opportunity cost in agriculture.

SUMMARY

The agricultural employment situation in Northeast Thailand can be summarized by saying it is dominated by productive opportunities in the wet season and extremely limited opportunities in the dry season. Even in the wet season, a large portion of the labor force has

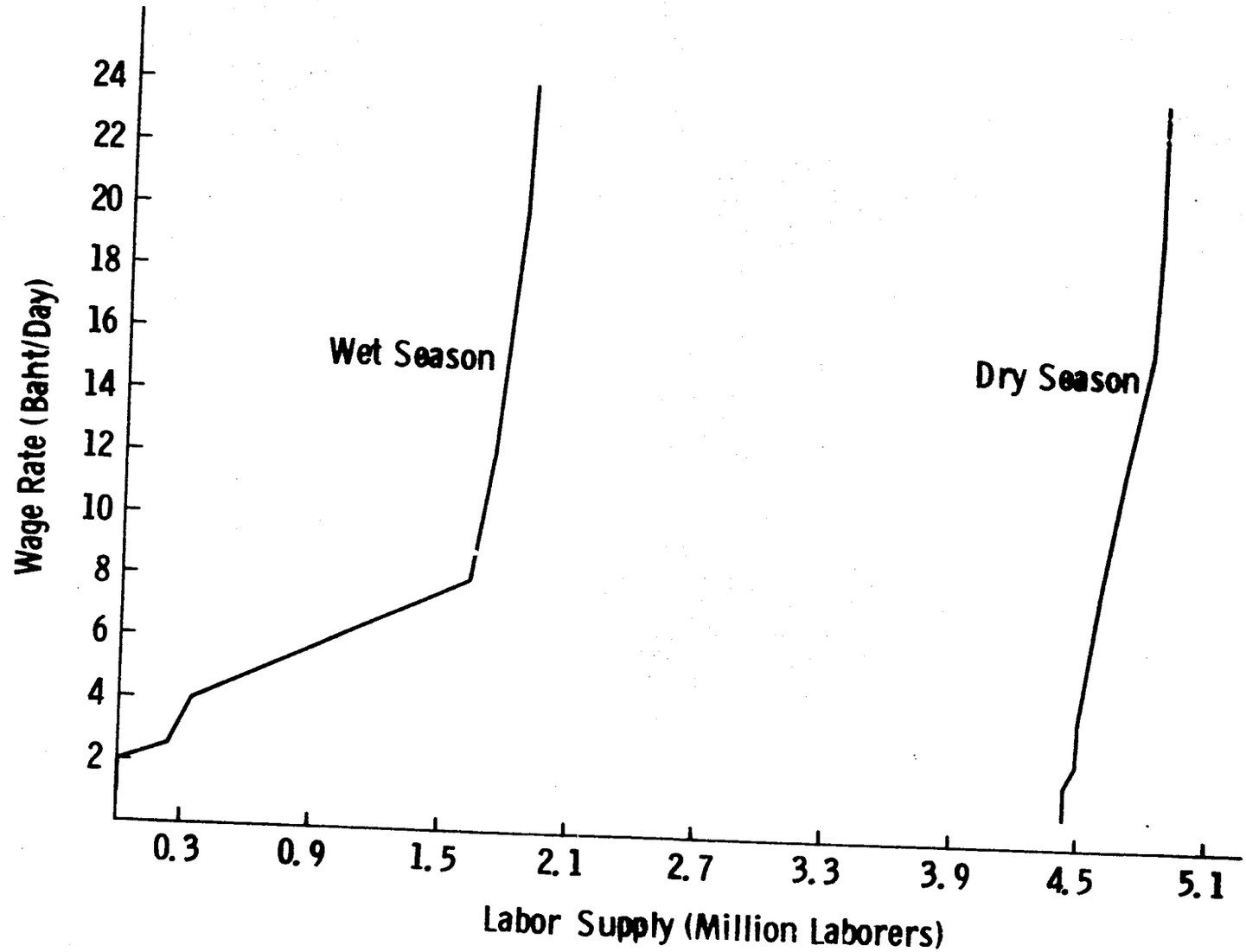

Figure 8. Potential Labor Migration Off-Farms at Alternative Wage Rates in Northeast Thailand - Base Year 1971-72[a].

[a]Source: NEREGON - Solution 13 and 14.

productivity far below the minimum wage rates set by the government. This points to a need for increased use of modern technology so that productivity and income can be raised. Several sources have suggested that growth of the nonag sector was lagging behind population growth in Thailand and that agriculture would have to absorb the surplus labor force. Based on the preceding analysis, that appears to be a totally infeasible alternative in Northeast Thailand unless per capita income in the agricultural sector is going to fall proportionately. There already is a surplus of labor, unemployment or underemployment, and any further increase in the labor supply without corresponding increases in cultivated area, capital inputs, or new technology will simply result in greater unemployment or more severe underemployment. However, if the agricultural resource base could be expanded and a conducive economic environment developed, it appears that agricultural production, employment, and income could be expanded in the Northeast. Early attention must be focused on creating employment opportunities for the four million people whose productivity is less than one Baht per day during five months of the year. Employment outside of agriculture is not necessarily the solution either, even if possible, because withdrawals of labor during the key planting and harvesting months would probably decrease agricultural production. Agricultural employment and production is an integral part of the economy of the Northeast, as is the Northeast an integral part of the national economy. Any proposed action to deal with the employment and income problem in Northeast Thailand must be analyzed carefully to determine the potential impact on other sectors and regions.

REFERENCES

1. Agriculture Statistics of Thailand, Crop Year 1972-73. Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture and Cooperatives, No. 25, 1974.

2. Agro-Economic Zones for Agricultural Extension and Development. Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture and Cooperatives, September 1972.

3. Annual Report--Agricultural Sector Analysis--Thailand. Iowa State University, Contract AID/CM/SA-C73-19. June 1974.

4. Research Strategies for National Agricultural Planning in Thailand. Division of Agricultural Economics and Iowa State University Team. 1973.

5. Rogers, Keith D. and Prasit Itharattana. Regional Agricultural Development Planning in Thailand--Northeast Crop Model (NEREGON). Bangkok, Thailand, Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture and Cooperatives. Working Paper No. 2. May 1975.

6. Rogers, Keith D. and Prasit Itharattana. Regional Agricultural Development Planning in Thailand--Rice Supply Response in Northeast Thailand. Bangkok, Thailand, Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture and Cooperatives. Working Paper No. 4. June 1975.

7. Rogers, Keith D. and Prasit Itharattana. Regional Agricultural Development Planning in Thailand--Kenaf Supply Response in Northeast Thailand. Bangkok, Thailand, Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture and Cooperatives. Working Paper No. 5. July 1975.

8. Rogers, Keith D. and Prasit Itharattan. Regional Agricultural Development Planning in Thailand-- Cassava Supply Response in Northeast Thailand. Bangkok, Thailand, Division of Agricultural Economics, Office of the Under Secretary of State, Ministry of Agriculture and Cooperatives. Working Paper No. 6. August 1975.

9. Rogers, Keith D. and Prasit Itharattana. Regional Agricultural Development Planning in Thailand--Maize Supply Response in Northeast Thailand. Bangkok, Thailand, Division of Agricultural Economics, Office of the Under-Secretary of State, Ministry of Agriculture and Cooperatives. Working Paper No. 7. September 1975.